LUME 51 NUMBER 8 . . . . ONE YEAR THREE FIFTY

GENERAL ELECTRIC
REVIEW

Illinois U Library

TABLE OF
CONTENTS
Page Three

GUST
48

Here's the flexible insulation you need...

FOR HIGH HEAT APPLICATIONS

UNDERWRITERS' APPROVED FOR
105°c
CONTINUOUS OPERATION

THE NEW TURBO REL 16-A

THERMO PLASTIC TUBING

FEATURING:

- ★ PERMANENT FLEXIBILITY
- ★ EXTREME HEAT RESISTANCE
- ★ NON-COMBUSTIBLE
- ★ MOISTURE ABSORPTION LESS THAN 1%
- ★ HIGH DIELECTRIC STRENGTH
- ★ SMOOTH WALL FINISH
- ★ EXPANDED RANGE OF WALL THICKNESSES

REL 16-A is the new heat-resistant TURBO Thermo-plastic Tubing that provides an economical and dependable solution to most electric insulating problems involving high temperature. Approved by the Underwriters' Laboratories for continuous operation at 105° Centigrade, REL 16-A safely withstands even higher temperatures intermittently, without deterioration of mechanical or electrical characteristics. In addition to complete stability under high heat, REL 16-A tubing provides permanent flexibility—maintained under severe temperature conditions, high dielectric strength , negligible moisture absorption (less than 1%). Typical applications in which this tubing offers important advantages over ordinary tubing include the insulation of coils and wiring where baking, potting or soldering is required; equipment with high thermal rise; enclosed units such as motors, generators, transformers, etc. Write today for complete laboratory test results, including UL reports, on TURBO REL 16-A. Samples on request.

TURBO

WILLIAM BRAND & COMPANY
276 4th Ave., New York 10, N.Y.—325 W. Huron St., Chicago 10, Ill.

Manufacturers of TURBO FLEXIBLE VARNISHED SLEEVING, FIBROUS GLASS TUBING, PLASTIC INSULATED WIRE, MICA AND MICA PRODUCTS, VARNISHED CAMBRICS, INSULATING PAPER and TAPES, WIRE MARKERS

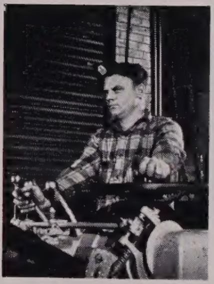
GENERAL ELECTRIC REVIEW

AUGUST, 1948
Vol. 51, No. 8

J. S. SMITH
Manager

E. C. SANDERS
Executive Editor

J. E. GLICK
Associate Editor



THE COVER

A solution to one of the problems of reducing the cost of handling materials in factories and warehouses. Typifying use of modern equipment for that purpose, the cover photograph (a production still from the motion picture "Materials Handling—In Receiving, Warehousing, and Shipping") shows an operator at the controls of a battery-operated fork lift truck. A general consideration of materials-handling problems and their related aspects is presented in the article on page 33.

ADVERTISING INDEX

Aluminum Company of America..........3d cover
American Brass Co.......................... 4
Anaconda Copper Mining Co.................. 4

Brand & Co., Wm......................2d cover
British Thomson-Houston Co. Ltd.............15

Canadian General Electric Co. Ltd.............45
Clare and Co., C. P.......................... 1
Clarostat Manufacturing Co., Inc..............45
Combustion Engineering Corp.................51
Cornell-Dubilier Electric Corp................ 8

Distillation Products, Inc.....................16
Driver-Harris Co........................... 7

Edison Storage Battery Div. of Thomas A. Edison, Inc......................................48
Edison-Swan Electric Co. Ltd................15

Ferguson, Pailin Ltd..........................15

General Electric Co..........29, 30, 32, 47, 53, 55
Giannini & Co., G. M.........................56

Harcourts Ltd..............................15
Hotpoint Electric Appliance Co. Ltd...........15

Ilsco Copper Tube & Products, Inc............28
Instrument Specialties, Inc...................52

Luria Bros. & Co., Inc........................15

Mallory & Co., Inc., P. R.....................36
Metropolitan-Vickers Electrical Co. Ltd........15
Metropolitan-Vickers-GRS Ltd................15
Meyercord Co..............................58

National Carbon, Inc......................... 2
New Departure—Div. General Motors Corp.....37
Norma-Hoffmann Bearings Corp.............. 9

O.Z. Electrical Manufacturing Co.............. 6

Penn-Union Electric Corp.................... 5

Roll-A-Reel Co..............................56

Sexton Can Co., Inc.........................45
Sherron Electronics Corp.....................60
Sola Electric Co......................4th cover
Speer Carbon Co............................54
SKF Industries, Inc..........................57

West Virginia Pulp & Paper Co...............15

EDITORIAL CONTENTS

FRONTISPIECE: Load Visualizing 10

ARTICLES:

Some Problems in the Industrial Applications of Atomic Energy . . . . Dr. K. H. Kingdon 11

The first problem is how to design and construct a suitable nuclear reactor. Progress toward the solution of that problem is being made, and also in learning more about how to utilize the reactor's thermal output and radioactive products

Electric Power in Industry: Its Past, Present, and Future . . . L. A. Umansky 17

In the Petroleum Industry . . . . T. R. Rhea 20
In the Mining Industry . . . . R. S. Sage 21
In the Steel Industry . . . . H. W. Poole 23
In Paper and Textile Industries . . . . G. W. Knapp 24
In Sewage-treatment Plants . . . . C. E. Miller 25
In Industrial Heating . . . . R. M. Cherry 27

Problems of Materials Handling . . . . . J. R. Kilander 33

Comments on a phase of industrial operations that provides a virtually untouched field for research in the possibilities it holds for savings in production cost and efficiency

A Versatile A-c Load Visualizer . . . . . P. J. Walton 38

Combined in a single instrument are means for determining load characteristics the measurement of which previously has required the readings of several conventional instruments

A-c Motor Drives for Modern Elevators . M. A. de Ferranti 41

Some of the requirements for satisfactory drives and how the squirrel-cage induction motor is used to meet them

DEPARTMENTS:

High Lights and Side Lights . 46
New Products 49
Trade Literature . . 53
Book Reviews . . 56
Library Notes . . 59

INDEXED BY INDUSTRIAL ARTS INDEX, ENGINEERING INDEX, SCIENCE ABSTRACTS

Editorial Advisory Board: H. A. WINNE, Chairman • H. L. ANDREWS
Dr. W. R. G. BAKER • H. V. ERBEN • Dr. WARD HARRISON

CIRCULATION DEPARTMENT: General Electric Review, Schenectady 5, New York.

SUBSCRIPTION RATES: *Payable in advance.* United States and Possessions and countries in Pan-American Union, one year $3.50, two years $5.50. Canada, one year $3.75, two years $5.75. Other foreign countries, $4.00 a year, $6.00 two years. Public and college libraries, professors, and enrolled students deduct $1.00 from annual rates. SINGLE COPY 35¢

CHANGE OF ADDRESS: Give old and new addresses. Notices received before the fifteenth of the month will be effective with the next issue.

ADVERTISING DEPARTMENT: General Electric Review, Schenectady 5, New York.

Entered as second-class matter, March 26, 1912, at the post office at Schenectady, N. Y., under Act of March 3, 1879. Published monthly by General Electric Company, 1 River Road, Schenectady 5, N. Y. Printed in U. S. A. *Copyright 1948 by General Electric Company.*

You'll WANT THIS BOOK
Everdur
ELECTRICAL CONDUIT
THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT

Write for it Today...

INCREASING use of Everdur* Electrical Conduit in refineries from coast to coast is the logical result of experience in test applications.

Extensive Everdur Conduit installations in the Port Arthur Plant of the Texas Company, for instance, showed no deterioration after 10 years constant exposure to corrosive vapors indoors, or moist saline outdoor atmosphere.

Similar reports from other industries and utilities covering installations in paper mills, sewage plants, bridges and tunnels provide a wealth of evidence on the long, dependable service to be expected of Everdur Conduit under highly corrosive conditions, and where it is often subjected to severe vibration.

Write today for your copy of the new edition of Anaconda Publication E-12 with detailed information on Everdur Conduit and available stock fittings, hangers, clamps and accessories fabricated from Everdur Copper-Silicon Alloys.

48222

*Reg. U. S. Pat. Off.

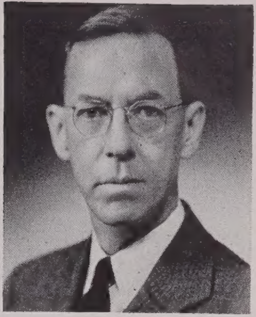
ANACONDA
from mine to consumer

Everdur
ELECTRICAL CONDUIT

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD.
New Toronto, Ont.

SOME PROBLEMS IN THE INDUSTRIAL APPLICATIONS OF ATOMIC ENERGY

The first problem is how to design and construct a suitable nuclear reactor. Progress toward the solution of that problem is being made, and also in learning more about how to utilize the reactor's thermal output and radioactive products



KHKingdon

By Dr. K. H. KINGDON
Knolls Atomic Power Laboratory
Research Laboratory, General Electric Company

WHEN at the end of the last war the General Electric Company set about organizing its peacetime program of research, it was only natural that the subject of the development of atomic energy should be in the forefront of our thoughts. As a result of our research and manufacturing participation in the work of the Manhattan District we already had, even before the publication of the Smyth Report, some idea of the vistas of development in atomic energy which had been opened up by the wartime project. It seemed to us that the discovery of the neutron, of uranium fission, and of chain reactions, opened up new fields of research and development rivaling or exceeding those made available at the beginning of the century by the discovery of the electron.

Our first step was to attempt to augment our technical staff by recruiting men from the laboratories of the Manhattan District which were then breaking up. In this we were quite successful and were able to recruit a number of men having good experience in the fields of physics, chemistry, and metallurgy, gained from work on the Manhattan Project.

We then set about establishing our program in this new field and at once ran into the first problem in the industrial application of atomic energy, namely the stone wall of security. We had no access to details of the backlog of classified information without which serious work in this field would be impossible, and we had no access to the materials which we would need for this work. We had men in our atomic energy group who from their wartime experiences knew a good deal about the design of nuclear reactors and a good deal about radio-chemistry and allied matters, but these men were not legally free to use their knowledge for experimental work in our Laboratory and, moreover, had no materials to work with. In this predicament there was nothing that could be done except to wait for the Government to formulate policies in this field, and, accordingly, our staff turned its attention to new developments in the field of very high energy particle physics, a type of work in which our Company was already well established.

Atomic Energy Contract With Government

Early in 1946 a break came, and we were asked by the Government to undertake work in the field of atomic energy. These negotiations culminated in a contract, signed on May 15, 1946, for carrying out certain work in this field. This contract was obviously of considerable mutual advantage to both parties. On our side, we had already decided that the field of atomic energy was one in which we wished to undertake research and development. From the Government's point of view, it seems pretty clear that the development of atomic energy will proceed much more rapidly if the resources of industry are thrown into the development.

The contract called for the performance of two main tasks: (1) the continued operation and development of the Hanford Works for the production of plutonium, and (2) the carrying out of research and development in the field of peacetime applications of atomic energy. The Hanford Works had been constructed by the DuPont Company and represented an outstandingly fine achievement in the field of engineering design and construction. The DuPont Company wished to discontinue operation of the Hanford Works, as they felt that they had no long-range, fundamental interest in this field. The Hanford Works was operated first by the Chemical Department of our Company and later by the newly formed Nucleonics Department which was created especially to carry on this type of work.

The research and development part of the contract is being carried out at Schenectady and is the responsibility of the Research Laboratory. We have organized a special division of the Research Laboratory called the Knolls Atomic Power Laboratory to carry out this work. At present the work is being carried on in temporary quarters, but a new laboratory is under construction at the Knolls, a site about five miles from the General Electric Works in Schenectady and adjacent to the new General Electric Research Laboratory which is well advanced in construction.

Industrial Applications of Nuclear Reactors

Turning now to the industrial applications of atomic energy, we may quote from the third semi-annual report of the United States Atomic Energy Commission, which states that "industrial applications of reac-

---

This article was presented by the author at the Toronto, Canada, May 26, 1948, meeting of the Canadian Manufacturers Association.—Ed.

This article is so paged that, without mutilating other articles, it can be readily removed for filing as a group of full-size consecutive pages.—Ed.

tors may be for the large-scale generation of electrical power, for the production of high-temperature process heat, and for special purposes such as remote stationary power installations or for the irradiation of materials."

The concept of a nuclear chain reaction as used in a nuclear reactor or pile has become a familiar one. A nuclear reactor is a very special assemblage of fuel material, moderating material to control the energy of the neutrons, coolant to remove the heat, various structural materials to form the supporting framework, and shielding to confine the intense radiation. This assembly is so proportioned that the neutrons liberated from the fission of one atom of uranium will cause the fission of just one more atom of uranium, so that the fission process is self-sustaining. The products of the fission process are neutrons, heat (which arises mainly from the kinetic energy of the fission fragments), radiation, and the radioactive fission products themselves.

The primary use of the neutrons, of course, is to maintain the chain reaction, but any excess neutrons may be used for carrying out other nuclear reactions, such as the production of more fissionable material, plutonium, for example, or for the production of special radioactive isotopes, and so on. The heat generated may be extracted from the reactor by a suitable coolant and used for the generation of useful power. The radiation and the radioactive fission products are merely nuisances as far as the operation of the reactor itself is concerned but, of course, have other and very important applications outside of the reactor.

Specifications for Reactor Components

Mention was made of the chief functional components of the reactor, namely, the fuel elements, the moderating material to control the energy of the neutrons, the coolant to remove heat from the reactor, the structural materials to form the supporting framework of the reactor, and the shielding required to confine the intense radiation. All of these materials must satisfy very exacting specifications, such as the following.

They must have satisfactory low neutron absorption characteristics. The supply of neutrons available from the fission process is barely adequate to carry out the essential functions of the reactor, so that great care must be taken not to waste any of the neutrons in absorption by various materials from which no benefit is obtained.

All materials used in the reactor must be resistant to corrosion by the coolant or by the atmosphere in the reactor, and to deterioration by the operating temperature. Practically all the materials inside a reactor become intensely radioactive after the reactor has been in operation for a short time, so that extensive maintenance work within the reactor structure is practically impossible. Accordingly, all structural parts must be designed with the idea of prolonged operation without need for replacement or maintenance.

The interior of an operating reactor is filled with an intense flux of neutrons and radiation. This flux will break up chemical compounds, displace atoms in a crystal-lattice structure, and in general bring about quite important changes in the sub-microscopic structure of any material within the reactor. These materials must, therefore, be chosen to withstand this kind of use. In fact, this matter of radiation stability is one of the most serious problems confronting the designer of a nuclear reactor.

Many of the materials which satisfy the specifications that have just been briefly outlined are not the ordinary materials of engineering design, so that one is faced with the problem of producing these materials in a satisfactory state of purity and of developing methods for fabricating them into the shapes needed in the reactor.

The construction of a nuclear reactor also requires the development of a large number of auxiliary items, such as pipes, valves, blowers, pumps, instruments and controls, mechanisms for feeding in the fuel and removing it, protective casings for fuel materials, and so on.

Power from a Nuclear Reactor

One of the main objectives in the design of an industrial nuclear reactor is to have it operate at a sufficiently high temperature to permit the generation of useful power. The fission process itself is a very intense sort of thing and the energies of the fission fragments are of the order of a hundred million volts, as compared with an energy of one or two volts which is characteristic of the atoms taking part in an ordinary chemical reaction. It is clear, therefore, that the fission process may be used to develop extremely high temperatures, the temperature limit being set by the characteristics of the materials of which the reactor is constructed and not by the fission process itself. The thermal energy is produced in such concentrated form in a nuclear reactor that the thermal flux occurring in the reactor may easily far exceed the thermal fluxes encountered in ordinary heat-transfer processes. One does not proceed very far with the design of a nuclear reactor without finding that a most important problem is that of getting the heat out of the nuclear fuel and into the coolant stream.

This brings us to another important objective in the design of a nuclear reactor. We have just seen that the nuclear fuel is itself capable of supplying heat at as high a temperature as materials of construction can stand, and at almost any rate that may be desired. It is clearly desirable to take as much heat as possible out of each kilogram of fuel in the reactor, for by doing so one lessens the capital charges against the fuel which is necessarily tied up in the reactor merely to make the chain reaction self-sustaining. One objective of reactor design, therefore, should be to operate the reactor at as high specific power as possible—that is, to get as many kilowatts as possible from each kilogram of fuel material in the reactor.

The "Breeding" of New Fuel in a Reactor

It was mentioned earlier that more neutrons are produced in the fission process than are required to maintain the chain reaction in the nuclear reactor. These extra neutrons may be used to produce more nuclear fuel by causing a nuclear reaction in some fertile material in the reactor. For example, they may produce plutonium by reacting with the natural uranium-238 that is in the reactor. If the amount of new nuclear fuel produced in this way is greater than the amount of fuel burned up in the reactor, then the reactor is said to be a "breeder."

When one remembers that the only kind of fissionable material that occurs naturally in the world in sufficient quantity to be of practical use is uranium-235, it is clear that the breeding process is of the utmost importance for its successful large-scale development will enable us to convert all of the uranium-238 and all of the thorium in the world into fissionable materials from which we may subsequently obtain atomic energy. Therefore, one of the major long-range problems in the design of an industrial reactor is to make the breeding gain as high as possible so that as much new fissionable material as possible is produced by the reactor.

One of the outstanding things about the construction of a new nuclear reactor is the tremendous amount of thinking and calculating and talking and designing and testing which must be done before the construction of the reactor is actually begun. This is partly because so many unknown or partly known things may be involved in the construction, and partly because such a reactor is a very expensive proposition. It is a multimillion dollar job and one cannot afford to make mistakes.

Another point that should be emphasized here is that only about 20 per cent of the work involved in the detailed design of a new reactor is nuclear physics. There is also a great amount of classical physics, chemistry, metallurgy, and engineering, so that the design staff must be very diversified. This fact emphasizes the importance of drawing industry into this development, for just this diversification is offered by the technical staff of a large industrial company.

Other Uses for Nuclear Reactors

It has been suggested that there may be a considerable field of industrial application for nuclear reactors in developing high-temperature process heat for carrying out various chemical processes. As we have said before, the only limit to the temperatures which may be developed is set by the materials of construction, so that if materials can be found to withstand the temperatures and pressures that are needed for any given process the nuclear reactor may be a very suitable source of heat for carrying out that process. If the chemical reaction is carried out within the reactor itself, the chemical product must, of course, be able to withstand the radiations present within the reactor. If this is not practicable, the heat must be extracted from the reactor as in power development and the chemical process carried on outside the reactor. As far as I know, no industrial applications of this sort have been made yet.

This brings us to the last application of nuclear reactors which I wish to mention, namely, the use of the reactor for irradiating materials so as to produce either new elements or materials with greatly changed physical properties. Early announcement was made of the production of neptunium, plutonium, americium, and curium by the exposure of materials to neutrons in a neuclear reactor. In addition to this, the Smyth Report mentions that graphite exposed to neutrons in a reactor undergoes large changes in electrical resistance. These changes presumably arise from alterations produced in the crystal lattice of the graphite, and similar changes may be expected in many materials.

One might at first sight think, then, that here is a method for producing a great variety of substances having new properties. This is true, but we must keep very clearly in mind that these altered substances are going to be extremely expensive. For, if the production of these new altered substances involves the absorption of neutrons in the reactor, we have then lost the neutrons as far as the possibility of producing new fissionable material and power from these neutrons is concerned. If a new material of this sort is built up molecule by molecule by the absorption of neutrons, a simple calculation shows that the cost of this new material per pound is really tremendous in terms of the potential electric power which was sacrificed in using the neutrons to make this new material. Such use of the neutrons is obviously justifiable in the case of new fissionable materials like plutonium and uranium-233, but it seems likely at present that the industrial use of such artificially produced or modified substances will be limited sharply by their very high cost.

Radioactive Tracers in Industry

Leaving this discussion of nuclear reactors, let us look for a moment at the possible applications of radioactive tracers in industry. Much has been written about the large variety and amount of radioactive materials produced by reactors, and about the successful use of these materials in medicine and biology.

One would expect, therefore, that there would be many obvious applications of radioactive tracers in the development, study, and control of industrial processes. This, however, does not appear to have been the case so far, and in most of the industrial tracer applications which have been suggested, a closer inspection of the problem reveals some serious difficulty. For example, consideration was given to a possible application of radioactive carbon to the control of a certain chemical process. In that process, a mixture of two chemicals—a trichlor-compound and a dichlor-compound—is fed into a still, which is supposed to remove all the former from the latter. The chemical problem is to ensure that the dichlor-compound issuing from the still does not contain more than a specified percentage of the trichlor-compound. This could be solved very neatly by adding a certain amount of radioactive carbon to the trichlor-compound going into the reactor and then looking for traces of the trichlor-compound in the product materials by a radioactive method. This control process would be very convenient for it would require only about 1/20th of the time taken by the present chemical control process. However, closer analysis of the problem shows that in order to handle the dichlor-compound annual output of the plant concerned, it would be necessary to add half a curie of radioactive carbon to the input feed, and at present prices this radioactive carbon would cost about $25,000. This means that in spite of the convenience of this control method it is now too expensive.

Similar considerations hold in practically every industrial application of radioactive tracers which we have thought of. However, it appears likely that in the future the cost of these tracers will be reduced sufficiently to permit widespread industrial applications. In the case that was described, the cost of the tracer would have to be reduced by a factor of about ten to make it feasible.

Protection of Personnel From Radioactivity

It will be evident from the preceding considerations that industrial applications of tracers will probably involve rather large amounts of radioactive materials, and this at once brings us to the problem of protecting personnel against excessive exposure to radiation. All possibilities for such exposure must be guarded against. For example, if a biological laboratory were to undertake an extensive program involving giving radioactive carbon to animals, the animals would exhale radioactive carbon dioxide from their lungs, and an elaborate program of air monitoring and ventilation would be necessary to make sure that the air in the laboratory was safe for the staff to breathe.

It is obvious that the operation of a large industrial nuclear reactor will require very thorough health-physics monitoring to insure that radiation damage is prevented in the surrounding area. This monitoring must be particularly good if plutonium is used because the ingestion of microscopic quantities of this or similar substances into the body may be fatal.

The requisite health-physics procedures include setting up suitable standard techniques for handling radioactive materials, provision of adequate hood space and ventilation, the monitoring of laboratory equipment and apparatus, the monitoring of the clothing and hands of the laboratory personnel and of the air that they breathe, and arrangements for insuring that no radioactive wastes escape into the atmosphere or into the ordinary sewer system of the laboratory.

In addition, all personnel must always wear radiation measuring devices such as film badges and pocket electrometers to measure the radiation dose received, and must undergo periodic blood counts to look for radiation damage, and bio-assay measurements to look for the ingestion of radioactive materials. This all sounds very complicated and indeed it is, but no halfway measures are adequate to supply the complete assurance against radiation health damage which is essential for the successful industrial application of atomic energy.

One reassuring fact in this problem is that the instruments with which radiation is measured can detect radiation which is less intense by several powers of ten than that which would injure the human body. Adequate protection is therefore entirely possible, but one must organize effectively to obtain it. In our laboratory about 15 per cent of the total staff of scientists and technicians is devoted to this job. The general standard set by health-physics is to insure that reactors and other strong sources are so well shielded that radiation from them outside the shield is about equal to that due to cosmic rays—that is, to about 0.2 milli-roentgen per day.

In addition to that general background, a worker may have to take calculated radiation exposures, such as might arise for example from handling large blocks of uranium. All such exposures are measured and must not be allowed to exceed 50 milli-roentgens per day. These figures refer to dosage over the entire body, and for comparison it may be stated that if the x-ray dose actually received in getting a set of x-rays of one's teeth were averaged over the whole body, it would amount to 100 to 1000 milli-roentgens.

Mention was made of the fact that the disposal of radioactive wastes from a plant or laboratory requires health-physics supervision. This matter of waste disposal is one of the most serious problems confronting the industrial application of atomic energy. If the nuclear power industry develops to be a considerable fraction of our present electric power output, the amount of radioactive waste to be disposed of per year will amount to many billions of curies, even after storing the waste in tanks for perhaps a year to get rid of the short-lived products. The problem is a soluble one, but it is clear that adequate standards and procedures must be set up and enforced on a national scale to take care of the problem.

The Problem of Security

Reference was made earlier to the problem of security in atomic-energy work. Security control is very much with us in this field at present, so that one might as well accept the fact and try to live satisfactorily with it. The prime requirement is to have a technical staff which is trustworthy from the security point of view, in addition to being technically capable. My own experience has been that the great majority of scientists with whom I have come in contact take their security responsibilities seriously and are discreet and trustworthy. Then there is the possibility that security restrictions may be so thwarting that good men will not work in the field or will rapidly lose their initiative and drive. Security seriously restricts publication of papers or their presentation at scientific meetings, and limits discussions with other scientists. Palliative measures include regular scientific meetings attended by those working on restricted projects, and prompt declassification procedures for those papers which are suitable for publication. The restrictive features of the work are to some extent counterbalanced by the unusual or unique possibilities for research and development offered by atomic energy laboratories, so that it has been possible to recruit very capable people and to keep them interested.

In conclusion a brief appraisal should be made of the probable importance of the industrial applications of atomic energy. We have all heard the most diverse estimates of this ranging from the miraculous to the inconsequential. Actually, of course, it is probably neither of these. Industry has for many years exploited the behavior of individual atoms, and of the combination of atoms into the molecules of innumerable chemical compounds. In more recent years the outer parts of atoms, namely the electrons, have been exexploited thoroughly in the electronic industry.

The recent developments in atomic energy have now taken us into the heart of the atom where the regrouping of protons and neutrons is analogous to the combinations of atoms into molecules, and where the rather mysterious exchange forces and mesons take the places of electromagnetic theory and electrons. The abundant production of neutrons through nuclear chain reactions has made available to us these supreme alchemists of this micro-space, and the energies released by nuclear reactions are of the order ten million times greater than those released by ordinary molecular reactions.

All the ingredients for new and important industrial developments seem to be at hand, and it will be surprising if these developments do not ensue.

Serving

Since 1880, we have served Industry by purchasing and shipping Scrap to consumer— mills and foundries. Fair dealing is our constant aim.

CONSULT OUR NEAREST OFFICE FOR THE PURCHASE OR SALE OF SCRAP

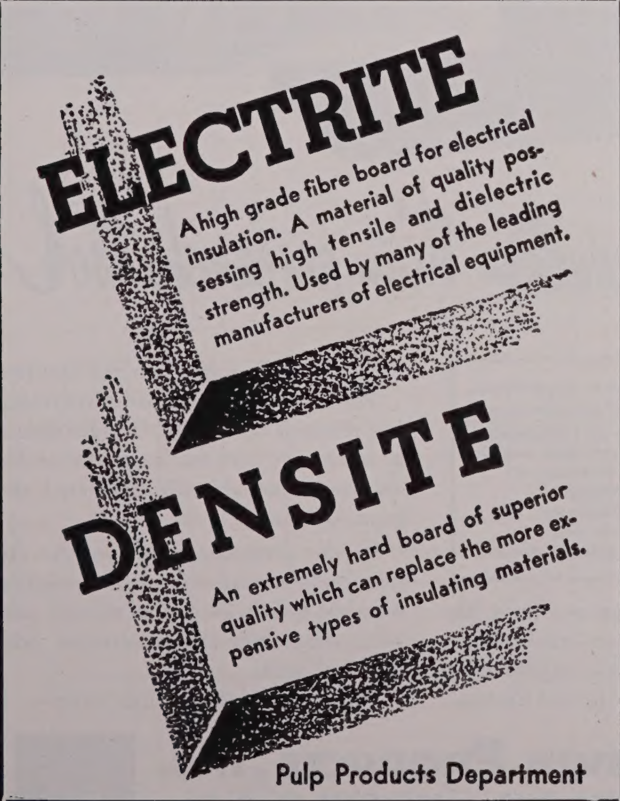
LURIA BROTHERS & COMPANY, Inc.

Main Office
LINCOLN-LIBERTY BLDG.
PHILADELPHIA 7, PENNSYLVANIA

Yards
LEBANON, PA. • READING, PA.
DETROIT (ECORSE), MICH.
MODENA, PA. • PITTSBURGH, PA.

Branch Offices
BIRMINGHAM, ALA. Empire Bldg.
BOSTON, MASS. Statler Bldg.
BUFFALO, N. Y. Genesee Bldg.
CHICAGO, ILL. 100 W. Monroe St.
CLEVELAND, O. 1022 Midland Bldg.
DETROIT, MICH. 2011 Book Bldg.
HOUSTON, TEXAS Cotton Exchange
LEBANON, PA. Luria Bldg.
NEW YORK, N. Y. Woolworth Bldg.
PITTSBURGH, PA. Oliver Bldg.
PUEBLO, COLO. Colorado Bldg.
READING, PA. Luria Bldg.
ST. LOUIS, MO. 2110 Railway Exchange Bldg.

LEADERS IN IRON AND STEEL SCRAP SINCE 1889



ELECTRITE

A high grade fibre board for electrical insulation. A material of quality possessing high tensile and dielectric strength. Used by many of the leading manufacturers of electrical equipment.

DENSITE

An extremely hard board of superior quality which can replace the more expensive types of insulating materials.

Pulp Products Department

WEST VIRGINIA PULP & PAPER COMPANY
230 Park Avenue, New York, N.Y. 35 E. Wacker Drive, Chicago, Ill.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

British Thomson-Houston Co. Ltd.

Edison-Swan Electric Co. Ltd.

Ferguson, Pailin Limited

Harcourts Limited

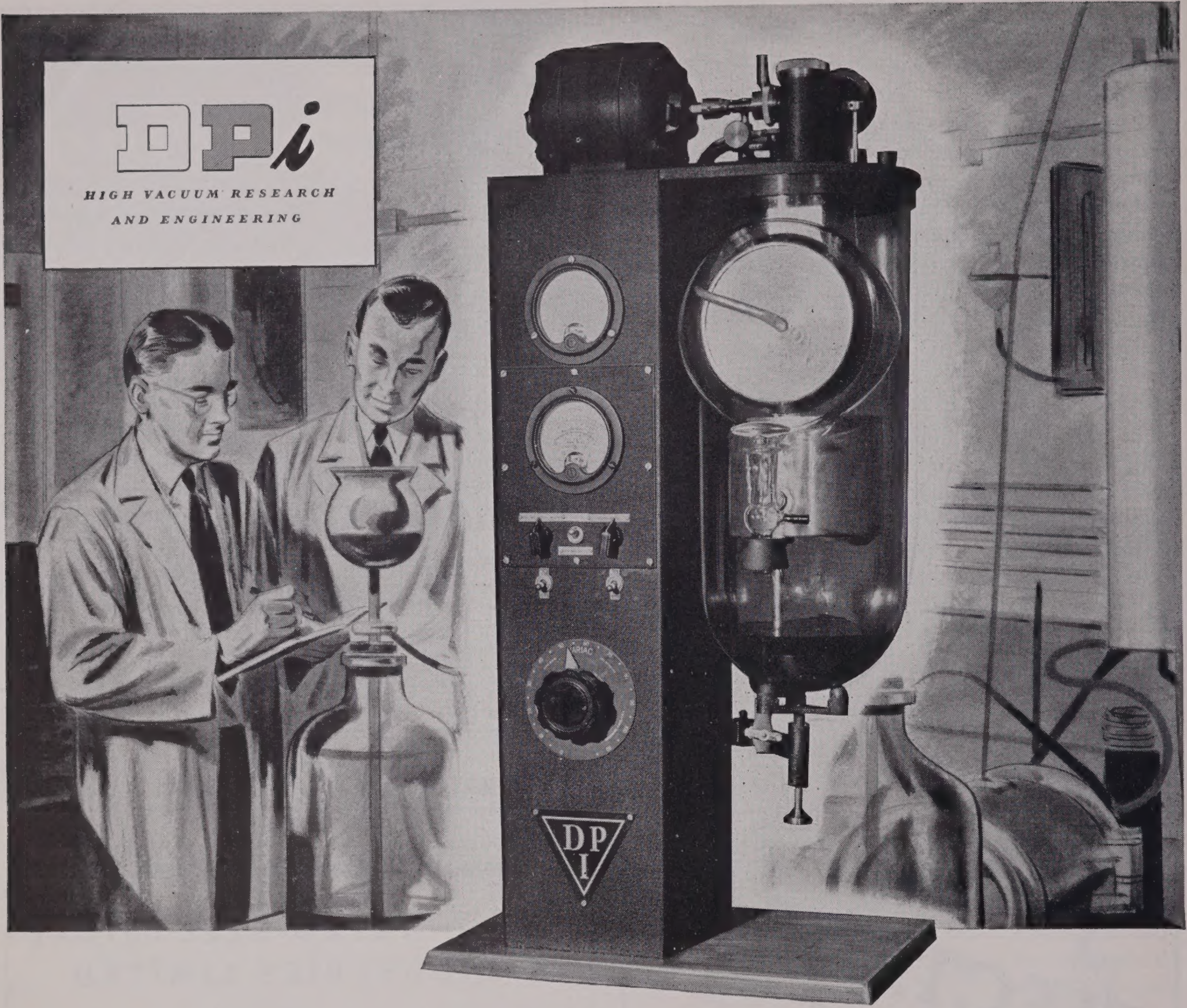
Hotpoint Electric Appliance Co. Ltd.
(Incorporating International Refrigerator Co. Ltd. and Premier Electric Heaters Ltd.)

Metropolitan-Vickers Electrical Co. Ltd.

Metropolitan-Vickers-G R S Ltd.

•

Agents and Licensees of the
GENERAL ELECTRIC Co., U.S.A.
for the United Kingdom.



Somewhere a Scientist awaits this research tool

MOLECULAR distillation now used in the separation of heavy oils once thought undistillable, in the extraction of precious drugs, vitamins and hormones, and in the processing of foods, chemicals and plasticizers is returning millions of dollars to these industries.

But there is yet a vast field to be explored.

Research men in science and industry, utilizing high-vacuum distillation, may discover many things which will prove a boon to humanity in better health and better living.

That is why DPI has brought out the CMS "5" high-vacuum centrifugal still, specifically designed for laboratory use. This compact unit, 32″ high on a base 1 x 1½ ft. can rest on a lab bench. It is a precision instrument, versatile, easily operated, highly efficient in maintaining the lowest thermal decomposition hazard so far attained.

Announcing a High-Vacuum Centrifugal Still designed especially for laboratory use.
DPI now makes available an inexpensive Molecular Still for research and experimental separation and distillation of
Oils, Resins, Plasticizers
Drugs, Vitamins, Perfumes
Extracts, Fatty Acids and
Complex Experimental Mixtures

For the express purpose of encouraging research in Molecular Distillation in university and industrial laboratories, this new lab still is offered at a moderate price.

If your processing involves the distillation of substances with molecular weights above 200, you should provide your research department with this new tool.

For further information write—

DISTILLATION PRODUCTS, INC.
773 RIDGE ROAD WEST • ROCHESTER 13, N. Y.

DP
I

Manufacturers of Molecular Stills and High-Vacuum Equipment; Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry

ELECTRIC POWER IN INDUSTRY:

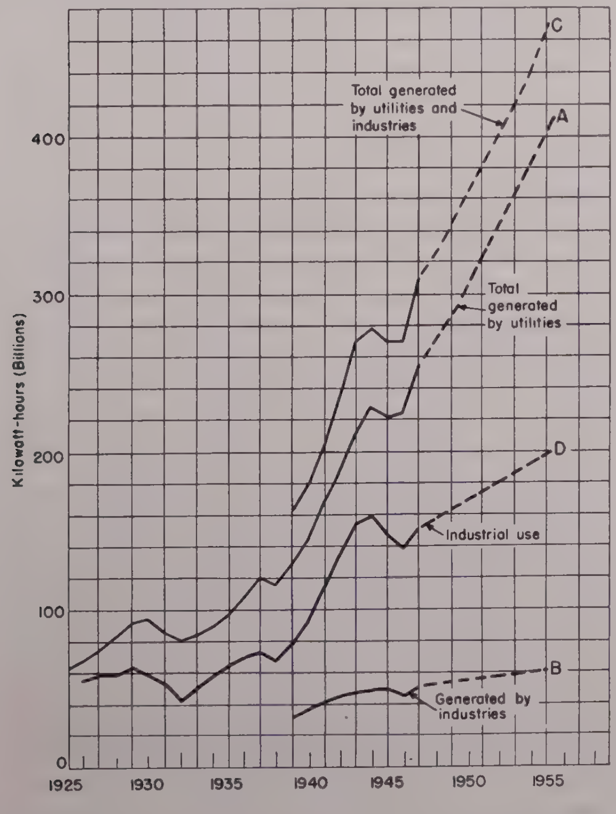
Its Past, Present, and Future

By L. A. UMANSKY
Assistant Manager, Industrial Engineering Divisions
General Electric Company

THE industrial load is large and growing fast. It utilizes by far the largest portion of the total electric energy generated in the United States. For instance, in 1947, industrials used 151 billions of kilowatt-hours, or 56.5 per cent of the total power generated (after power-house and transmission losses are subtracted). We do not expect that this proportion will drop materially in the foreseeable future. True, we expect and hope that the domestic and farm load will grow by leaps and bounds. At the same time we have other, equally good, evidence which points to the rapidly growing industrial load, and to the fact that industrial demand for power and for electrical equipment will not be saturated for many years to come.

Chart I is a record of the past 22 years and a projection to the year 1955. Curve A shows that the energy generated by utilities has increased four-fold in the past 22 years, from 61 to 256 billion kilowatt-hours, and is shooting to over 400 billions in 1955. Curve B, the power generated by the industrials themselves, also goes up, but at a much lower rate. Add these two curves together and we get Curve C, which is the over-all power generated in the country. Finally, Curve D shows the total industrial use of power, regardless of its source.

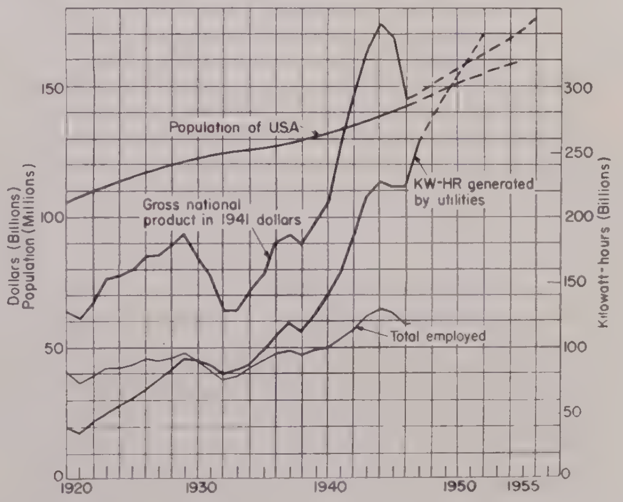
CHART I
Total generation of electric power and the relatively large part of it that is used by industries, with projection to 1955



It is interesting to note that last year the industrials have used more power than the total generated by the utilities just seven years ago, in 1940. We can also note in passing that the industry is progressively generating a smaller proportion of its own power demand; from 40 per cent in 1939 it dropped to about 33 per cent in 1947, and will probably be around 30 per cent by 1955.

Consideration will now be given to the factors which contribute to the phenomenal growth in the industrial use of electric power.

CHART II
Curves showing the growth of population and the increase in number employed; and the much higher rate of increase in goods produced, largely due to corresponding increase in use of electric power



Three Major Factors

There are three major factors that act cumulatively. First, we have to recognize the growth of population, as shown in Chart II. Of course, we, as electrical engineers, do not claim any professional credit for this rise. The fact remains, however, that this nation is far from dying out—a 35 per cent increase in the last 27 years, a probable total of 160 millions by 1955. The proportion of those employed in good years to the total population does not change appreciably in this period. It is also to be noted that the curve of gross national product,

---

This article was delivered by the author as a paper at the Adirondack Industrial Power Sales Conference, Sacandaga, N. Y., June 7–8, 1948, at which conference it introduced a number of other papers several of which follow in somewhat abbreviated form.—ED.

This article and those associated with it can be readily removed for filing as a group of full-size consecutive pages.—ED.

i.e., the value of all goods and services, expressed in 1941 dollars, has increased 2.3 times, while the power generated has increased better than six-fold.

This brings us to the second factor: We produce more goods per man because we use more power. Only by producing more goods can we increase our standard of living. This fact is the cornerstone on which our civilization is based; and as there is no natural limit to the rise of standard of living, so there is no limit to the amount of power which a man can use. When we say power, we mean electric power, since even now the industry is 90 per cent motorized.

At the turn of the century, the average production worker in the American industry had 2.2 hp of mechanical power at his service; he worked 60 hours per week and was getting an equivalent of 45 cents an hour (expressed in purchasing value of 1944 dollars). In 1940 he had three times the power, worked less than 40 hours per week, and his real wages were more than double. And this process goes on unabated.

Chart III illustrates the evolution in electrical terms. It covers only 18 years but includes 1929 and 1947 both of which were full production years. The number of production workers in manufacturing industries increased from 8.7 to 12.6 millions, or 50 per cent, but each man now uses approximately 11,000 kw-hr per year instead of 6500. To put it differently, at the end of these 18 years the industry has given to each of its workers annually some extra 4500 kw-hr which at one cent cost only $45, but this extra power has contributed largely to raising the worker's real annual wages by some $650 (in the same 1944 dollars), while his working hours were cut from 44 to 40 per week. With that much more power available, each man produces more coal or steel, more rubber tires or automobiles, more yards of cloth, or more of whatever his product may be.

This is the obvious answer of industry to the problem of higher wages and higher standards of living. To repeat: There is no inherent reason why this continuous struggle should ever cease. Therefore, the conclusion can be drawn that the greater use of power per worker, i.e. the second factor, will keep on growing in value and importance.

But there is also a third factor involved, and it sometimes overlaps the second one. Not only each worker produces more, due to the greater use of power, but we find that each unit of production—each ton of coal, each pair of nylons, each barrel of cement—in effect contains more kilowatt-hours.

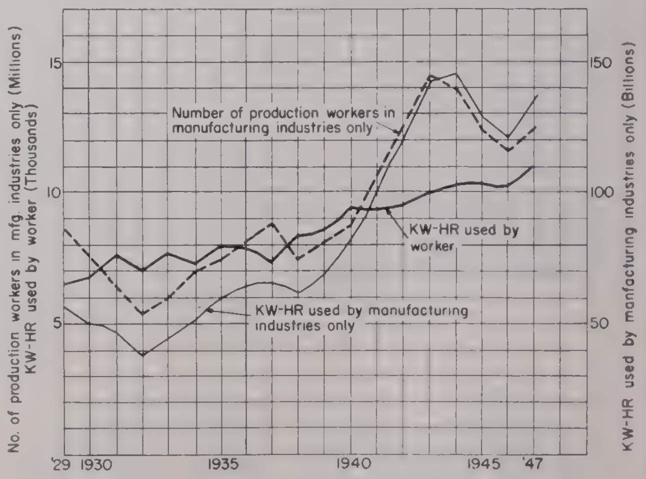
That increase in the kilowatt-hour content per unit of production is illustrated in Chart IV. In this chart are compared two years, both good years, 1939 and 1947. Column A is the Federal Reserve Board Index of Industrial Production—a composite of such tangible items as steel and coal tonnage, automobile production, car loadings, power generation, and the like. Column B is, again, the kilowatt-hours used by industry in the corresponding years. Both indices show a very rapid rise. But, if we divide the kilowatt-hours by the production index, we will find that in the short period of these eight years the use of electric energy per unit of production has gone up 10 per cent.

There are several reasons for that phenomenon. In the first place, it is obvious that when electric power replaces manpower the electric content of our products is going up as a sequel. But there are deeper reasons than that. In addition to acting as a source of mechanical power moving the wheels of industry, electricity is becoming more and more a chemical or thermal agent in the industrial processes themselves.

We have increased several times the production of light metals since 1939. Each pound of aluminum requires 10 kw-hr for electrolytic refining. This is 20,000 kw-hr per ton, as against some 200 kw-hr per ton for ordinary steel. But even in the steel industry we produce three to four times as much electric-furnace steel as we did before the war, and each ton of this product takes about four times as much electric power to produce.

CHART III

Curves showing the steady increase in amount of electric energy utilized per worker in the manufacturing industries, thus enabling the worker to increase his output and income



Our electrochemical industry is expanding on several fronts, increasing the production of such elements as chlorine, sodium, and many others. Electric welding is a well established and rapidly growing production tool. Last, but not least, we are still replacing on various fringes of the industry some mechanical drives with electric motors, as for instance in the oil fields, on construction projects, and the like.

We should also recognize another important event: We are actually depleting some of our heretofore abundant natural resources. For instance, the low-grade iron ores and synthetic fuels, on which we may have to rely before very long will require a tremendous additional amount of power per ton, and that will be over and above all other needs for power.

We have, then, three major factors working cumulatively: (1) the growth of population; (2) the greater use of power per worker; and (3) new uses of electricity in industry, increasing the electrical content of the product. Under the circumstances, the forecast for the industrial load, as given by the several charts, is rather on the conservative side.

Proportion of Purchased Power Goes Up

The trend of industrial plants to buy a greater portion of electric power, rather than to generate it, is unmistakable and can be readily explained. If we exclude some few remote plants where no utility service is available, the only economic justification for an industrial plant to generate its own power is the presence of by-product heat, gas, or steam, resulting from the industrial process itself. Experience has shown that such generation makes sense only insofar as this by-product heat is available; any additional power, if needed, can normally be obtained more economically by purchase than by burning some prime fuel to generate it.

Now, the amount of by-product heat in an industrial process is more or less fixed per unit of production, like a ton of steel or a barrel of oil. This limits the amount of power which an industrial plant can generate economically. If, on the other hand, the power per unit of production goes up, as it does, the need for a greater share of purchased power goes up likewise.

Other factors, of course, add to this trend: The greater reliability of utility power; its continuing low cost as against the greatly increased cost of installing and operating a separate plant.

Modernization of Industry

Electrification of industry is a far greater task than a mere increase in the amount of electric power used. A plant which many would call 100 per cent electrified may be the most fertile ground for additional or new electrical equipment. The so-called modernization is never complete; in fact its tempo is mounting from year to year.

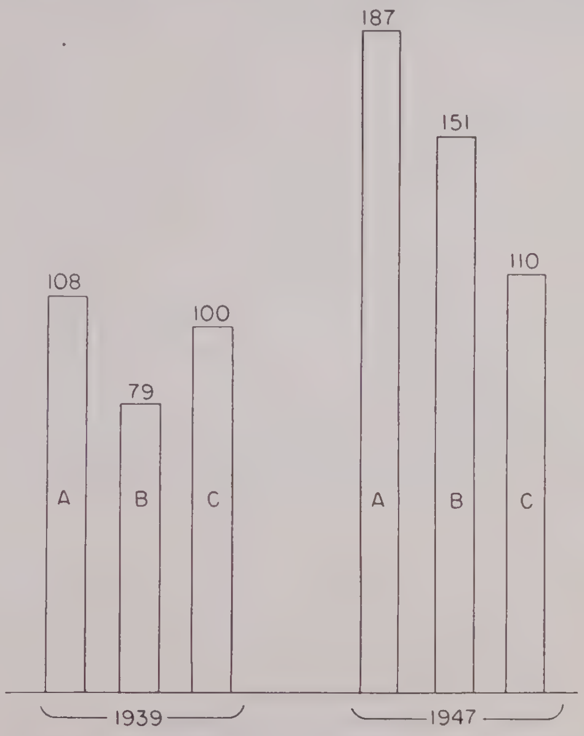
It is not the electric equipment but the industrial processes themselves that are rapidly and continuously growing obsolete. It is then up to the electrical engineers to scrap or revamp the old material, and to invent and add new equipment in order to make the new processes possible.

Modernization may take 1001 different shapes and forms. The general trend is to make the process continuous, reduce the expense of material handling, increase the operating speeds, add automatic controls, and reduce the danger of human errors.

When we double the speed of a machine tool, of a rolling mill, or of a rubber calender train, we have to double the power of the electric drives. New equipment is obviously needed; but the power consumption per unit of production does not necessarily go up. However, the output of the machine goes up with the same operating crew. As the sequel, the labor cost goes down even though the worker usually shares in the resultant economy. If this change brings—as it often does—a lower price for the finished product, everyone benefits. The demand increases, a new machine is built, and before long we have two high-speed machines in place of two low-speed ones. Those of us who are maintaining close contact with industry are observing this evolution every day. One modernized plant causes its competitors to toe the mark and modernize in turn. Someone usually goes a step farther, and the rivalry starts all over again.

CHART IV

While the production of goods (A) and the use of electric power by the manufacturing and mining industries (B) both increased greatly from 1939 to 1947, the latter increased faster so that the kilowatt-hour content per unit of production in 1947 was ten per cent greater than in 1939



A: Federal Reserve Board Index of industrial production (1935–39; ave. = 100)
B: Kilowatt-hours used by manufacturing and mining industries (in billions)
C: Ratio of B to A (assuming C = 100 for 1939)

Electric equipment is steadily growing more involved in order to simplify the mechanical parts of the machines with which it is associated, and to make the process more nearly automatic. A few years ago we would be proud to find that lineshafts and belts in a machine shop had disappeared and that each tool has a separate motor. We do not stop now at that point: We may provide each tool with a half-dozen motors, one for each of several motions. Some of these drives are of adjustable-speed type, with fine controls. Obviously, the cost of such equipment is much higher, but the users gladly pay the difference because the machine produces more, the range of products is greater, and the mechanical maintenance is less. This case is typical and may be multiplied a thousand times, in all lines of industry.

The progressiveness of electrical engineering is widely known through its continually bringing to industry the latest scientific discoveries and laboratory developments. For instance, an x-ray gage measures the thickness of a hot sheet coming out of the rolling mill at some 2000 fpm, thereby reducing scrap and therefore costs. Another laboratory gadget indicates the tension of yarn on a spinning frame, pointing out how to improve the product and speed up the operation. The field of electronics is particularly fruitful in providing industrial aids: Their uncanny sensitivity extends the range of human senses and makes possible previously unheard-of quality control, combined with high-speed mass production.

Here, again, electricity makes contribution to industry. The power consumption is not increased, but the electrical consciousness of the industrial leaders is enhanced. The bond between industry and electrical engineering is being made stronger every day.

Conclusion

The foregoing reasons are the principal ones why we sincerely believe that the industrial applications for electric power and equipment will not approach a saturation point within our lifetime. Observing industry every day, and knowing intimately the factors which have pushed the industrial power use sky-high in the past years, we are confident that our predictions for its future growth are rather conservative.

We know, of course, that all these elements of growth and expansion do not work by themselves. Rich soil and a lot of sunshine are needed for a good garden; but it takes a good deal of spade work and planning to get worthwhile results.

. . . IN THE PETROLEUM INDUSTRY

By T. R. RHEA
Chemical and Petroleum Divisions
Industrial Engineering Divisions
General Electric Company

TODAY more Btu energy is extracted from petroleum and natural gas than from coal. This condition will not continue. Oil companies and geologists are shouting that oil is precious, and that it must be conserved. More and more of the Btu requirements must be based on coal, and this means that more coal Btu's will be turned into electric power. Petroleum products and synthetic liquid fuels must more and more be conserved for automobiles, airplanes, diesel locomotives, and ships.

As the value of petroleum products increases, whether or not the resource is conscientiously conserved, economics will force the change; and this means more electric power based on coal, even in the petroleum industry. Recently it was remarked that one of the East Coast refineries would save one million dollars per year if their fuel were coal instead of petroleum products. And if a refinery cannot afford to burn petroleum under its boilers and stills, who can?

Probably the world oil production will average more than three billion barrels per year in the decade 1947–1956. Competent geologists estimate 72 billion barrels of "proved" world reserves. It would be erroneous, however, to make the easy arithmetical calculation that the world's oil will be exhausted in 24 years. Past experience indicates that the "proved" reserves are only a fraction of the actual reserves, but whether the fraction is one half or one tenth is of very great importance in the application of electric equipment and power to the petroleum industry.

From the petroleum reserves in the United States about 1.89 billion barrels were removed in 1947. In spite of this vast removal rate of oil, the "proved" reserves at each year's end have been greater than at the beginning. However, additions to "proved" reserves show a definite tendency to level off and the peak may be reached in 1950; after that, the United States must increasingly depend upon existing "proved" reserves.

It may be that the world's reserves of petroleum are adequate to meet the world's needs for half or three quarters of a century, assuming that all of the political factors permit us to draw on the oil from the rest of the world. At this moment there are no grounds for extreme optimism that the political factors will permit us to freely draw on the world's reserves. With these factors in mind, there is every reason to expect the gradual replacement of natural petroleum products by synthetic products in the more distant future, and very marked changes in the use of natural petroleum products as they become more precious. There is enough oil shale and coal in the United States alone to provide the equivalent of two billion barrels of crude oil a year for at least a thousand years. Liquid fuels from natural gas will also be a factor in the transition.

Synthetic Fuels

Synthetic fuels are made from coal or natural gas by a thermal mechanical process involving the manufacture of large quantities of oxygen and wide use of compressors. About 40 per cent of the original fuel is spent in partial burning to sustain the process.

Based on knowledge of synthetic fuel plants now being constructed, a synthetic liquid fuel program of two billion barrels a year would require about 700 billion horsepower-hours per year to produce. A large amount of this would be in mechanical-drive turbine-compressors, using heat from the process, but a large amount will also be electric power. This is almost twice as much power per year as is now generated by all the utilities. Process improvements in producing synthetic fuels will be made, but the energy requirements will still be very large. Certainly, the transition from natural petroleum to synthetic fuels is going to affect, even in the next one or two decades, the economics we have been accustomed to consider in applying electric equipment, and it is going to affect the type of electric equipment we apply to the petroleum industry.

Oil Wells

Approximately 30,000 wells are drilled each year, by some four or five thousand rigs. Only about 100 of these rigs are electric and most of these use internal combustion engines as prime movers.

The transmission of power from the engines to the work is being done electrically in some cases, but this practice requires the exercise of application engineering and sales effort because such changes do not come about automatically. The search for oil is being pushed even out over water on large barge-mounted drilling rigs.

This intensive search for oil is only one illustration of how the changing petroleum picture is affecting the electrical industry.

A proved field (not wildcatting) can be drilled electrically with purchased power. This also has been done. It seems to be economical to distribute a-c power around a field, convert it for d-c deep drilling or use it as a-c for shallow drilling. For such a power distribution system, portable mine cable might be used.

Of the 375,000 wells now on the pump, 23 per cent are pumped electrically and this percentage is increasing. Gas for gas engines is no longer free. If all of the wells were pumped electrically, they would require between five and seven billion kilowatt-hours per year, and such electric power could be based on coal.

A good deal of application engineering work needs to be done in this field, particularly in bringing down the cost of the distribution system. About two thirds of the cost of electrifying a pumping field is in the distribution system, and only one third in the motors and control. This will not come automatically. This is a task for industry.

Pipe Lines

There are about 72,500 mi of main crude pipe lines and 18,000 mi of products pipe lines in the United States. Serving these, there have been installed:

Electric motors	663,000 hp
Engines	860,000 hp

Over 90 per cent of all new crude and products pipe lines are now served electrically. These pipe lines consume about 1.5 billion kilowatt-hours per year.

There are about 220,000 mi of gas transit and distribution lines in the United States predominantly powered by gas engines. It is very difficult to beat the economics of having gas fuel for the internal combustion engines right at hand in the pipe line, particularly when the charge is only 10 cents or less per million Btu's. This picture will change and electric power, based on coal, will be used when gas becomes so valuable for other purposes that it is worth 30 or 40 cents per million Btu's.

Future Possibilities

Gas turbines driving centrifugal compressors will be applied to gas pipe lines but probably only near the beginning of the line where the gas is cheaper and does not have to be transported in expensive pipe lines. The rest of the line may be electrically powered and based on coal.

The big field for the application of electrical equipment is in the refineries. The consumption of electrical energy in refining has risen from about one kilowatt-hour per barrel at 1920 to about 3.5 kilowatt-hours per barrel at present. Since refineries process about 1.8 billion barrels per year, power consumption amounts to six or seven billion kilowatt-hours per year. And as petroleum products become more valuable, more energy per barrel will be expended on them to more highly refine them. Even as the volume of natural crude goes down, the total electrical energy consumption will go up.

As mentioned, truly staggering amounts of power will be required to make synthetic fuels. Even if research develops a synthetic liquid-fuel process, based on coal, that requires only half as much energy, and liquid fuels are rationed to a mere billion barrels a year, this will require power generation equipment about equal to all of the central station plants now existing. Perhaps such power plants will be integrated with large electrical systems.

Electrical energy on an extensive scale may be used directly in petroleum processes, such as the arc-discharge in natural gas to make acetylene.

Perhaps in 15 or 20 years it will be common practice to supply refineries with coal-fired steam-turbine-driven electric plants because the oil will be too valuable to burn there. Indeed, this has already happened in some refineries. New ways of applying electrical equipment and new electrical equipment requirements are as certain as tomorrow's sunrise.

. . . IN THE MINING INDUSTRY

By R. S. SAGE
Mining Division
Industrial Engineering Divisions,
General Electric Company

IN ELECTRIC energy requirements, the mining industry, including all its various divisions, stands at the top of the major industries. More than 7,000,000 hp utilized in electric drives, in this industry, insures doing the work effectively and efficiently.

Some idea of the quantities involved is indicated by the comparison in the following tabulation, which covers the annual tonnages of some of the basic raw materials produced from domestic sources:

Coal	685,000,000 tons
Iron ore	90,000,000 tons
Copper ore	86,000,000 tons
Zinc and lead	25,000,000 tons
Limestone	100,000,000 tons
(Included for comparison, the Panama Canal Excavation	400,000,000 tons; total to 1920)

Mining methods also are used to extract from the earth large quantities of other important minerals such as phosphate rock, potash, sulphur, salt, sands, gravel, crushed stone, clay, and the like.

Not only must these materials be wrested from their firm anchorage in the ground, sometimes at depths a mile below the surface, but many of them must be worked over and milled to separate out the valuable content from the waste material. The chief source of our supply of copper, for example, is ore containing only 19 lb of the metal for each 2000 lb of ore handled.

Power Requirements

For the task of winning these materials from the earth, some 10 billion kilowatt-hours of electric energy are consumed annually. This is approximately 40 per cent more than 10 years ago and this upward trend in power usage is expected to be continuing. Not only will more power be required for the greater tonnages which are needed to meet future requirements, but the trend is toward more electric energy per ton of material produced. The reasons for this trend are evident, for instance, in the bituminous coal industry where a steady increase is found in the mechanization of the mining processes. Whereas in 1920 the amount of coal mechanically loaded was only 7½ per cent of the total production, today more than 55 per cent is thus loaded. In the same time the energy consumption has risen from 3.8 to approximately 8.0 kilowatt-hours per ton. Mechanical loading, the last step in mechanization, reduces the total mining cost but increases the usage of power directly and also because the coal requires more mechanical cleaning and preparation before it is suitable for the market. Since it is estimated that it would be economically feasible to load mechanically from 75 to 80 per cent of all coal mined underground, there is much mechanization yet to be done.

Coal

It is generally conceded that the bituminous coal industry is on the threshold of events of great importance arising from the necessity for amplifying and eventually entirely supplanting the nation's dwindling gas and petroleum resources with similar products obtained from coal. Several full-scale experimental projects are now in various stages of operation or under construction. The extraction of gasoline, fuel oil, and other petroleum products from bituminous coal, if carried to the point of completely replacing the present sources, will require some 65 per cent more coal than is now being mined. This is expected to add some 3 to 3½ billion kilowatt-hours to the present energy demand for mining alone. Since sub-bituminous coal and lignite are suitable for such processing, many new areas in the nation may be expected to require electric service.

Copper

To satisfy the nation's requirements for copper, it has become necessary to dig deeper mines and to resort to deposits that heretofore were considered too lean for economical exploitation. With the greater demand and more attractive prices for the metal, plans are now being made to mine these low-grade, deep underground deposits. These operations, together with those involved in the concentration of the ore, which is necessary before smelting is feasible, presage an increasing demand for electric power to drive air compressors, mining machines, locomotives, hoists, crushers, grinding mills, and many types of concentrating machinery. As an example, one such project currently being actively exploited will require some 25,000 kw of electric power and consume an estimated half million kilowatt-hours per day.

Iron

The matter of the nation's future supply of iron ore is of great concern at present to our political and industrial leaders. The predicted depletion soon of direct-smelting ore, which for the past 75 years has fed the country's blast furnaces, poses the problem of commercially exploiting the almost limitless deposits of low-grade ores lying beneath those of higher grade in the great open pits on the Mesabi and other ranges in northern Minnesota, Wisconsin, and Michigan. These taconite ores with an iron content of 25 to 30 per cent, as contrasted with 51 per cent for direct-smelting ores, cannot be fed directly into the furnaces. They will require beneficiation into a concentrate with an iron content of some 65 per cent before smelting. These ores are very hard and for the most part nonmagnetic and not susceptible to processes such as are in use today for treating low-grade magnetite ores, which have been beneficiated for many years.

The beneficiation of these taconite ores, based on present knowledge of the requirements, is expected to necessitate the use of electric power in large quantities. This transition to total replacement of direct-smelting ores is expected to be gradual, and estimates place its consummation in from 20 to 30 years. Large expenditures (some estimates approach the magnitude of two billion dollars) will be required for machinery and plants for the extraction and processing of these low-grade ores. The nature of the ore makes necessary its crushing and grinding to the fineness of powder, or to at least 200 mesh. Whereas at present, only 2 to 4 kw-hr are used per ton of ore mined, it is expected, in reliable quarters, that some 75 to 80 kw-hr per ton of concentrate will be required to mine, concentrate, and pelletize (or sinter) these hard taconite ores. Based on these estimates, the iron-ore industry could be expected to require some half million or more kilowatts of new power and consume energy to the extent of 3½ billion kilowatt-hours per year.

Briefly summarizing, the mining industry, in many of its divisions, is entering into a new phase of its existence, generally due to the passing of the era during which the cream of our mineral wealth has been skimmed off. Future operations will involve practices which necessitate much greater and more extensive use of electric power than in the past; and it would appear that only through the application of electric energy can industry be geared up to the enormous demands for minerals to meet the changed conditions of our economy.

. . . IN THE STEEL INDUSTRY

By H. W. POOLE
Steel Mill Division, Industrial Engineering Divisions
General Electric Company

IN 1947 the steel industry produced approximately 85,000,000 net tons of steel and consumed approximately 200 kw-hr per ton—a total of about 17 billion kilowatt-hours. Only the electro-chemical industry rivals steel as a user of electric power.

The 85,000,000 tons of steel produced in 1947 in this country represents an average for each man, woman, and child of approx. 2/3 of a ton; production in England is about 1/3 of a ton per person; in China, about 1/150 of a ton per person. The steel industry recognized years ago the importance of electrically powered machinery and controls.

The electrical industry builds thousands of products for the steel industry, ranging from electric lamps to huge motors and generators. The demand for this type of equipment in the past two years has been the greatest in the industry's history—and even now orders extend as far ahead as 1950 for delivery.

Expansion

The steel industry will be an even larger user of electric power in the future. The industry has expanded greatly since V-J Day and is continuing to expand. Current programs scheduled for completion by early 1949 aggregate over one billion dollars for the expansion and improvement of the steel-producing capacity of this country. As a measure of the vastness of such a program, consider that one billion dollars is almost one half of the net value of all the plants, properties, and equipment in the entire steel industry today.

Since the end of the war, the American steel industry has ordered electric equipment for 38 cold-reduction strip mills, either for replacing existing electric equipment with greater horsepower and higher speeds or for completely new installations. In addition, the steel industry has placed orders for millions of dollars worth of auxiliary motors, electric controls, transformers, switching equipment, and lighting for use in these mills.

Kilowatt-hours per Ton Goes Up

The kilowatt-hours required to produce a finished ton of steel are increasing year by year. As a result, the total yearly power requirements of the steel industry are increasing even faster than steel tonnage is.

As an example, the increase in installed capacity of main-drive motors is more rapid than the increase in steel ingot capacity. For instance, in 1935 there were 37 hp in main-drive motors per 1000 tons of ingot capacity, while in 1947 there were 43 hp in main-drive motors per 1000 tons of ingot capacity. And this is not all: as the demand increases for more special steels and more operations are performed to obtain the required products, the various finishing processes—electroplating, electric annealing, and many others—require a greater ratio of kilowatt-hours per ton than ever before. Many of these processes have become so dependent upon electric equipment that the processes themselves are designed around the equipment.

As an example, we can consider the electric-arc furnace. The process of making high-alloy steels in the electric furnace depends entirely upon ability to generate very high temperatures by means of an electric arc. The arc-furnace capacity has increased substantially since 1935 from 1,050,000 tons to 5,076,000 tons in 1947.

Furthermore, the kilowatt-hours required to produce and finish the average ton of electric steel is approximately four times that required for ordinary steels produced in the open-hearth furnace—in other words, 200 kilowatt-hours per ton in one case as compared to 800 kilowatt-hours per ton in the other.

Source of Power

It is true that the steel industry is in a peculiarly favorable position to generate much of the required power. Blast furnaces are one of the basic elements of an integrated steel plant, and blast furnaces produce gas as a natural by-product. Approximately one half of this blast-furnace gas is used in the operation of the blast furnace itself, and the remaining 50 per cent could be used for power generation.

However, much of this excess gas is used for reheating furnaces, soaking pits, coke ovens, and other necessary processes. As a result, a relatively small amount is continuously available for power generation. Statistics show that twenty-five years ago the steel industry generated approximately two thirds of all electric power which it consumed. Today it generates only about 50 per cent of its requirements. The remainder is supplied by electric utility companies.

Modernization

Even without an increase in the annual steel tonnage, the power consumed would increase as a result of modernization and the use of more efficient but more complex processes.

Blooming-and-slabbing Mills

The blooming-and-slabbing mill rolls the steel ingot, produced by the open-hearth or electric furnace, down to a "bloom," or "slab," by passing it back and forth between the rolls until the desired shape is obtained for further rolling on subsequent mills. Of the 130 such mills installed in this country, 59 are still driven by steam engines. Some of these 59 steam-engine-driven mills will eventually be discarded and their output shifted to other existing or replacing mills.

If, however, only 60 per cent of these are either electrified or replaced with electrically driven mills, they will eventually represent a total increase in connected horsepower of approximately 200,000, an increase of approximately five per cent over the present total installed main-drive horsepower. This alone will represent a sizable increase in load.

Tandem Cold-strip Mills

Another example is the tandem cold-strip mill, which is one of the marvels of the modern steel plant. These mills roll steel for automobile bodies and tin cans. Such mills consist of a succession of mill stands arranged in tandem. The steel passes through each stand in succession and is coiled for further rolling, heat-treating, and processing.

New and improved electric machinery has teamed up with expanded production facilities to turn out more steel. At the Aliquippa Plant of the Jones and Laughlin Steel Corporation, for example, this new mill has turned out tin plate at a 70-mile-per-hour clip—more than double the best rate prior to 1940 and nine times as fast as the mills of 1933. In one hour, it can make sufficient strip steel for over 600,000 No. 2 vegetable cans.

The five mill stands and the winding reel are individually driven by six large d-c motors ranging from 1750 hp to 4000 hp in size. The two large motor-generator sets which supply power to the main motors are each driven by a 10,000-hp synchronous motor.

Conclusion

The steel industry is a progressive industry, and its progress is intimately tied up with electric power.

The annual tonnage is increasing, the kilowatt-hours per ton is increasing, and the percentage of purchased power is increasing. All this adds up to more profit for the steel producer, the electrical-equipment manufacturer, and the electric utility.

. . . IN THE PAPER INDUSTRY AND TEXTILE INDUSTRY

By G. W. KNAPP
Paper and Textile Division,
Industrial Engineering Divisions
General Electric Company

ELECTRIFICATION of the paper and textile industries is continually expanding because of the same economic forces at work affecting all industry.

The basic force in this electrical expansion is our growing economy. More production is needed for an increasing population, and also for greater per capita consumption—our increasing standard of living.

The second force responsible for expansion is technological. There is a tremendous urge in our business system for individual enterprisers to reduce costs and improve quality. New electrical technology and equipment contribute importantly to these goals.

Our Growing Economy

The influence of our growing economy is inferred from statistics. An increase of three million tons per year in paper production capacity is expected between now and 1955. The kilowatt-hours per year required by this industry will increase by two and one half billion between now and then. Furthermore, it is known that one horsepower installed is needed to make five tons of paper per year. It will be necessary, therefore, to add 600,000 hp in that time—about 500,000 kva—in motors, control, cable, transformers, switchgear, and turbines.

The paper industry requires large amounts of process steam (more than three pounds per pound of paper) for both cooking and drying. For this reason, the industry generates about three-quarters of its own power. Hence, the increase in central-station load over this period will be in the neighborhood of 0.6 billion kilowatt-hours per year.

In the textile industry the same fundamental trend in electrification is evident. This industry, however, buys most of its power from central stations, in almost the reverse ratio to the paper industry.

In the next nine years, textile production is expected to increase 10 per cent, with a corresponding increase in power consumption amounting to 0.9 billion kilowatt-hours. These figures may prove to be too conservative because they are based only on population increase, without a corresponding increase in per capita consumption. However, since the industry buys most of its power, central-station load can be expected to increase by about 0.7 billion kilowatt-hours.

About one horsepower installed is required for expanding the textile capacity by 2000 lb per year. With an increase of production equal to 0.6 billion pounds per year by 1955, the textile industry will need to install an additional 300,000 hp.

Technological Influences

The foregoing has shown how the natural growth of these industries will affect their requirements for electric power. Now, what of the technological influences applied under the stimulus to reduce costs and improve quality? Certainly electrification in both of these industries will be substantially affected—both in the rate at which power is consumed and in the amount of installed capacity.

Today there is a changing picture in the textile industry. Development programs are organized with trained, technical men in key positions. The old natural-fibre industry (cotton, wool, etc.) is being spurred on by the growth of synthetics. The latter industry, by its nature, must have highly trained technical personnel, and they want the latest and best equipment technology will permit.

For example, drives have just been installed for a number of continuous processing machines which make nylon yarn. Each machine produces 112 bobbins of yarn at the same time, and uses 225 motors, with electronic-amplidyne control that holds speed for maintaining yarn gage accurately. The natural-fibre industries must equip themselves to tackle problems with the same technical approach, if they are to remain competitive with synthetics. And they are doing so.

Examples of Expanding Electrification

For example, in the operation of spinning frames, it would be highly desirable to hold the yarn tension constant as it is spun, for better quality and to permit running the winding bobbins at higher speeds as the yarn builds up, for more production. In fact, for some work it is estimated that production can be increased by 25 per cent, and for most jobs by 15 per cent.

In present-day practice, ordinary constant-speed-drive motors are used, and the tension is allowed to vary with bobbin build-up. There has now been developed an adjustable-speed drive which will control the bobbin speed in a suitable program to hold constant tension and the highest allowable speed at any moment for maximum production.

In this country alone there are 65,000 potential applications for such a drive. Its use will represent a long step forward in further electrification of the textile industry.

The lumber industry furnishes another example of the technological advance towards greater electrification, namely, the log carriage drive for band mills. The carriage is used to push the log lengthwise in and out of the saw, making a cut on each stroke. Rapid acceleration and deceleration, plus high running speeds are of prime importance, since the speed of the log travel determines the saw production. Previously, steam pistons in cylinders (shotguns) have been used to provide this very fast back-and-forth movement. Such equipment used an enormous amount of steam, but wood waste had been a plentiful source of fuel. However, this situation does not always exist today. New uses for this waste, as building board, pressed logs, and wood flour for plastics, have given it new value.

Earlier attempts at electric drive were not always successful, because of the tough accelerating and decelerating requirements, but a new d-c drive has now been developed in which a motor and motor-generator set with amplidyne control supplant the steam shotgun. This new drive is cheaper to operate. In a recent instance, the cost for steam alone in a single shift was $33, whereas the cost of electric power was only $3. Moreover, it is capable of better control. The drive also is safer and requires less maintenance.

The lumber industry has a keen interest in such a development. Six such drives are already in operation and five more are under way. A development such as this can be counted as one of the technological advances which will increase the electrification of industry.

New tools with which to work are already at industry's disposal. Amplidynes, electronics, and others to come will continue to open new technological opportunities. The result will be more horsepower installed and more kilowatt-hours used.

. . . IN SEWAGE-TREATMENT PLANTS

By C. E. MILLER
Industrial Engineering Divisions
General Electric Company

SEWAGE-TREATMENT plants constitute an industry that is different in many respects from other industries; it is a relatively new industry; it is receiving a considerable amount of public attention; and it should not be overlooked as a prospective market for electric power and apparatus. There is now every indication that sewage works construction is on the way to a new high. This is based on a recent survey made by the U. S. Public Health Service which revealed that almost 40 per cent of the needed construction is at least in the planning stage.

Importance of Increasing Sewage-treatment Facilities

Even though the United States has the highest standard of living known, the sewage-treatment industry in this country is still in its infancy. Approximately 40 per cent of the urban population served by sanitary sewers are without a form of sewage treatment and, as a consequence, dump their untreated sewage into the nearest waterway. Consider this together with the fact that 75 per cent of our communities take their water supply from these same waterways.

Clean water is one of our most important national resources. It is essential to health, recreation, our fishing industry, wild life, and plant life. Stream pollution, on the other hand, is one of the main hazards to our public health, and in some instances it is so excessive that it is extremely difficult to produce a safe water supply, even with costly treatment. Moreover, pollution has made many of our beaches unfit for recreational use. Polluted waters also have destroyed much of our fishing industry. The U.S. Public Health Service estimates that pollution of our natural waters cost this country more than $100,000,000 annually, exclusive of many important intangible losses. These and many others are the reasons why this country needs more sewage-treatment facilities.

Pollution of our streams and waterways has been going on for many years. It is only in recent years, however, that the seriousness of this problem has been recognized by the general public. Many civic-minded groups are now organizing and campaigning on behalf of this nationwide problem. Recently, representatives of 1700 clubs of the General Federation of Women's Clubs in the Atlantic seaboard states pledged wholehearted support in a drive to eliminate stream pollution, and the American Legion has likewise adopted such a platform. Several states also have adopted strict legislation in regard to stream pollution.

Sewage-treatment plant expansion is a nationwide program. New plants and additions to existing plants will be fairly evenly distributed throughout the nation. Consequently, the increased electric load will be well distributed, and the major portion of this load is served by purchased power.

Although there is considerable activity in the sewage-treatment industry at the present time, it is expected that there would be a decided increase in activity should there be a depression. Thus, when other industrial activity is at a low level, these municipal projects would help materially in maintaining electric utility load. These projects also would provide much needed employment in the event of a depression, and they would be sound public works projects.

Power Requirements of Sewage-treatment Plants

The power requirements of sewage-treatment plants vary over wide limits. This is readily understandable in view of the fact that a large portion of the total power is required for pumping, and the amount of pumping depends on the topography of the location and the type of treatment plant employed. It is conceivable that a community located on the side of a hill would require very little power for pumping. Contrast this with a community on level ground or rolling terrain where outlying lift stations must be employed, or consider a location where a pumping station is required to pump the effluent out to sea.

Although the power requirements vary over wide limits, it does not eliminate the possibility of arriving at an average figure which can be used for making rough estimates for new projects. Based on 15 representative communities varying from 1200 to 2,000,000 population each, aggregating a total of over 4,000,000 population, records show an average power consumption of 16 kw-hr per year per capita. Only approximately half of these plants have complete treatment, thus this figure could really increase to 20 in the future. These same data indicate a very steady load as evidenced by a relatively high yearly kilowatt-hours per kilowatt demand of 4000 hr per year.

Since these are average figures, they should be used only for rough estimating. For extreme cases, when considerable sewage pumping is required because of the topography, or when the activated-sludge process is used, requiring considerable power for blowers, the power required may double or even triple.

At present, there are approximately 6000 sewage-treatment plants in the United States serving about 47,000,000 people. Applying the per capita figure previously given, the annual power consumption is approximately 750 million kilowatt-hours with a demand of approximately 200,000 kw.

Future Outlook

A nationwide survey completed last year by the Sanitary Engineering Division of the U. S. Public Health Service revealed that 12,000 new treatment plants are needed. The estimated cost of these new plants including outlying pumping stations is approximately $2,000,000,000. The cost of electric apparatus for a sewage-treatment plant varies from 5 to 10 per cent of the total, depending on the type of plant, size, etc. Based on an average of 7.5 per cent, this therefore represents a potential electrical market of $150,000,000.

Thus, about twice as many new plants are needed as there are existing plants at the present time. Admittedly, the average population to be served by these new plants may be somewhat smaller than for the present plants, but even so, it is expected that the total annual power consumption of sewage-treatment plants can easily reach 2 billion kilowatt-hours with a demand of 500,000 kw. In fact, it is very possible that these figures may be higher, even doubled, because of industrial waste, which in many instances exceeds by several times the domestic waste of the city in which these industries are located. This is a situation yet to be corrected.

The industry saturation point might appear to be reached as soon as all of the communities served by sewer systems are provided with adequate treatment plants. However, this is not necessarily a correct assumption, because: (1) household waste will continue to increase with increased use of garbage-disposal units; (2) waste increases with increased population (not altogether an increasing total population but partially due to a shift from rural to urban areas); and (3) industrial waste increases with industry expansion.

Electric Apparatus

The electric load of a sewage-treatment plant is composed primarily of motor-driven pumps, blowers, fans, and material-handling equipment. These motor drives range in ratings from a few horsepower in the small plants to 1000 hp per drive for some drives in large plants.

The utmost in reliability must be provided in all of the equipment in a sewage-treatment plant. Two power sources are generally provided wherever possible. Failure of any one piece of equipment may result in flooding, with consequent danger to health and damage to property. Modern utility power systems and electric apparatus have made it possible to provide the utmost in reliability and system flexibility. Automatic control, remote and supervisory control, and remote indication give an operator the ultimate in system flexibility and reliability. Such flexibility would be very difficult to obtain by any other means.

To many, the engineering problems involved in applying electric apparatus in the sewage-treatment field may seem rather elementary and uninteresting. However, that is far from being true. There are still many problems to be solved; special instruments and devices are needed; and much of the electric apparatus must withstand treatment under very adverse conditions involving grease, chemical, and corrosive conditions. Pumping systems incorporating automatic liquid-level control may involve very complex problems in system stability, requiring mathematical analysis to determine whether the system will operate successfully. In fact, this is exactly the circumstance for a pumping system employing adjustable-speed pumping units with automatic liquid-level control, especially when the level-control range is relatively small.

Conclusions

Here, then, is an industry that is very closely related to health, well-being, and prosperity of the nation as a whole. It is to everyone's advantage to see that pollution of our waterways is reduced to a minimum, and to this end more public pressure is now being brought to bear than ever before.

Although the electrical requirements of this industry may not be so large as those of some other industries, they do represent a potential market for the electric utilities and at the same time present opportunity for community service.

. . . IN INDUSTRIAL HEATING

By R. M. CHERRY
Industrial Heating Divisions, Apparatus Department
General Electric Company

THE industrial heating industry embraces a wide range of heating equipment for the use of clean, controlled heat in a multitude of applications. A mere enumeration of some of these suggests the magnitude of the power requirements for the various processes. Such a list would include induction and dielectric heating, resistance furnaces, arc furnaces, induction melting furnaces, salt baths, low-temperature ovens, and industrial heaters and devices.

Induction and Dielectric Heating

Of all the types of apparatus used for the many heating processes, none are so spectacular in their accomplishments as those for induction and dielectric heating. These new tools make it possible to do rapid and localized heating, thereby improving the quality and reducing the over-all cost of many products.

These equipments range in frequency from 960 cycles, as required for steel melting, to 40 megacycles, as used for dielectric heaters in the heating of plastic preforms.

Electronic heaters designed for frequencies up to 925 megacycles have been made for developmental purposes

In general, for the frequencies of 10,000 cycles and below, a motor-generator is used, and electronic type equipment is used for the higher frequencies. An outstanding example of the use of the lower frequencies of 2000 to 9600 cycles is that of heating for forging. During the war, this method of heating was adopted to speed up the forging and nosing of shells.

In one new forge plant the total installation of high-frequency equipment being used for the heating is approximately 8000 kw. This method of heating greatly increases die life by lessening the formation of scale. It also makes a forge shop a comfortable place to work.

An example of the use of the higher frequencies for induction heating is the surface hardening of the ways of lathe beds. In the process, the lathe-bed ways are mounted on a movable carriage that moves the lathe bed continuously under an inductor coil, which heats the surface to be hardened; this is followed by the water quench. The result is a uniformly hardened wearing surface, and longer life of the machine tool. Hundreds of such interesting applications of induction heating for hardening have been and are being made.

The use of high frequencies for dielectric heating of nonconducting materials (such as wood for gluing, plastic preforms, rubber, textiles, and paper) is just coming into use. Many interesting applications have been made and it is fully expected that this field of heating will rapidly increase.

An interesting application is the heating of paper cord for drying. It is necessary to have uniformity of moisture content to obtain uniform shrinkage, and it was found that this moisture content could not be controlled in the usual drying oven. It is readily accomplished by means of dielectric heating, however, when the cones of paper cord are passed continuously through an oven equipped with electrodes for generating the heat throughout the cone.

Another interesting application of dielectric heating is the heating of plastic preforms. The rapid and uniform heating increases production two to three times per mold, giving lower over-all costs and improved quality of product.

Resistance Furnaces

The use of the resistance furnace has steadily grown since the first commercial installation during the first World War. The trend to more and more electric heating for furnaces will continue to increase.

Some of the major new applications of electric resistance furnaces are:

(1). Continuous heating of steel strip for annealing before galvanizing

(2). Increased use of electric furnace brazing, particularly for larger assemblies. This brazing process continues to offer desirable opportunities for the use of electric power, as the process is one where cost savings are usually rather large

(3). Bright-annealing of steel parts before porcelain enamelling is another new application. Two such installations are now in successful operation, where hollow-ware stampings used for kitchen utensils are bright-annealed instead of pickled, to provide the proper surface for porcelain enamel. The results are improved quality of enameled kitchenware, improved working conditions, and lower costs.

The malleable-iron foundry provides a good example of what the electric resistance furnace can do to create load in a small industry. There are only about 110 such foundries in this country, yet the electric furnaces for this annealing process constitute a substantial load.

Electric annealing is fast becoming the established practice in these malleable-iron foundries. There are now a total of six such foundries where all the annealing is done electrically, and new installations are being made regularly.

ILSCO
LUGS AND CONNECTORS

It's a Fact!
ILSCO LUGS
ARE
10% to 20%
COOLER
than the heavy cast lugs you now use.

Prove it to yourself—

WRITE FOR SAMPLES and the Ilsco 54-page illustrated catalog.

ILSCO
COPPER TUBE
& PRODUCTS, Inc.
CINCINNATI, OHIO

KEEP AHEAD with the REVIEW

ELECTRONICS	MEASUREMENTS
MAGNETICS	DIELECTRICS
MOTORS & CONTROL	WELDING
LIGHTING	TRANSFORMERS
DISTRIBUTION	METALLURGY

are a few of the many subjects which are covered during the year, including their new applications and developments. Each article is written by an authority on that subject.

Reading the REVIEW regularly every month is a reliable, yet easy way for you to keep ahead.

Be sure you have *your own* copies for study and future reference.

SEND YOUR SUBSCRIPTION TODAY!
$5.50 for 2 years, or $3.50 for 1 year
Canadian Postage 25¢ additional

GENERAL ELECTRIC REVIEW
Schenectady 5, N. Y.

ELECTRIC POWER IN INDUSTRY

(Continued from preceding page)

At present, there are approximately seventy electric furnaces operating in these malleable-iron plants, but they represent less than 20 per cent of the total furnaces possible in this industry. When this industry is completely electrified, the total requirements will be approximately 400 million kilowatt-hours annually, even in this relatively small industry.

Glass Melting

A noteworthy application of electric heat is that for glass melting, where the glass is melted by using the molten glass as the heating unit. This is not exactly new, but the commercial installation of melting on a production scale and producing clear glass is relatively new.

One of the smaller glass plants has installed in the past few years a total of 4000 kw of glass-melting furnaces. Also two other glass plants are now installing developmental, but production size, melting furnaces. One will be a batch-type furnace, where the melting will be done at night and poured in the daytime, and the other will be a continuous-melting furnace.

As an example of what glass melting will mean as a power load, one company installing a batch furnace, of approximately 300-kw rating, will require approximately 30 to 60 such furnaces to handle their output, or a total potential load of 15,000 to 18,000 kw.

Such loads may develop slowly, particularly in the plants producing the cheaper glass products. This application is still too new to have sufficient data to properly evaluate in dollars all of the possible savings by the use of electric heating.

Heaters and Devices

Although the larger heating apparatus, such as the induction furnaces, and dielectric heaters, are more spectacular and require larger amounts of power per unit, the additional load created by the small heaters and devices commonly known as the "midgets" is several times the total added by the larger heating apparatus.

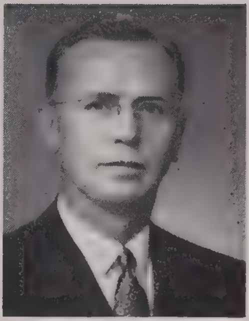
Millions of kilowatts, applied in the form of tubular, cartridge, and strip heaters are now used in such applications as liquid heating, soft-metal melting, surface and platen heating, air heating, and pipe heating.

The ratings of heaters and devices manufactured in 1947 aggregated approximately 1,000,000 kw. A large portion of this was for new installations. If an average use of 2000 hr per year of the full rating is assumed, then this will constitute a total of 2,000,000,000 kilowatt-hours annually.

Intelligent application of these industrial midget heaters and devices contribute to economical production from the standpoint both of product and power load. Well-equipped laboratory facilities are being maintained for the study of new applications and developments. This gives assurance of effective use of industrial heat and prepares the way for the utilization of surplus power that may be available in a few years.

PROBLEMS OF MATERIALS HANDLING

A phase of industrial operations providing a virtually untouched field for research in the possibilities it holds for savings in production cost and efficiency



By J. R. KILANDER
Apparatus Manufacturing Divisions
General Electric Company

J. R. Kilander

SINCE the beginning of civilization people have been struggling to bring together men, equipment, and materials as efficiently as possible.

Cost and time have always been important factors, whether for a cave man, who had to plan his hunting so that his kills were within carrying distance of his home, or for a plant manager considering the installation of a new conveyor. One of the reasons the Russians were defeated in the first World War was that they had planned their materials handling so poorly. Russia's major rivers run north and south, so they had built their railroads east and west. When the weather had a change of heart—rivers freezing and muddy floods ruining railroad roadbeds—one can easily imagine what happened.

*Here a battery-powered truck, this of the forked type, moves a load on a pallet of corrugated paper. These expendable pallets may be discarded when they have served their purpose, with saving of return shipping charges**

But we are concerned chiefly with the problems of materials handling in manufacturing operations, and there one chief problem presents itself. That is the co-ordination of men, machines, and materials into the manufacture of products that can be sold at ever decreasing cost. From that main problem a number of subordinate ones arise, usually in the form of specific questions. The unfortunate fact is that most of these are so intimately concerned with a particular business, or operation within a business, that specific answers cannot be given to them; the answers must come from within the businesses themselves.

It is in fact because of the inexact nature of materials handling that its problems and the savings possible from their solution have been so long unrecognized.

Interest of Management

One of the main problems that confronts materials-handling men almost everywhere is: How can we make top management more aware of our problems?

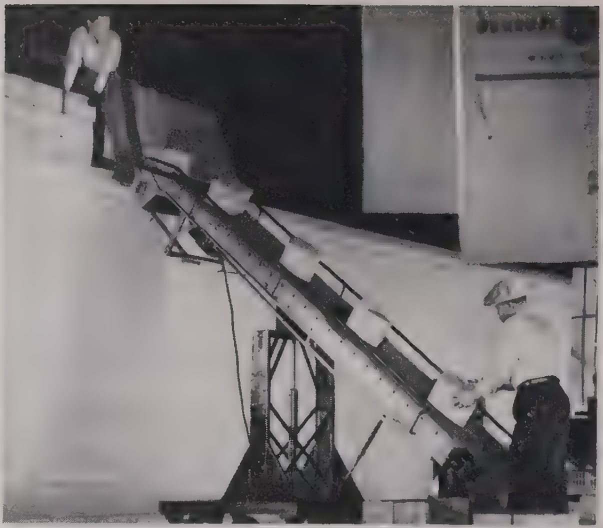
This article is so paged that, without mutilating other articles, it can be readily removed for filing as a group of full-size consecutive pages.—Ed.

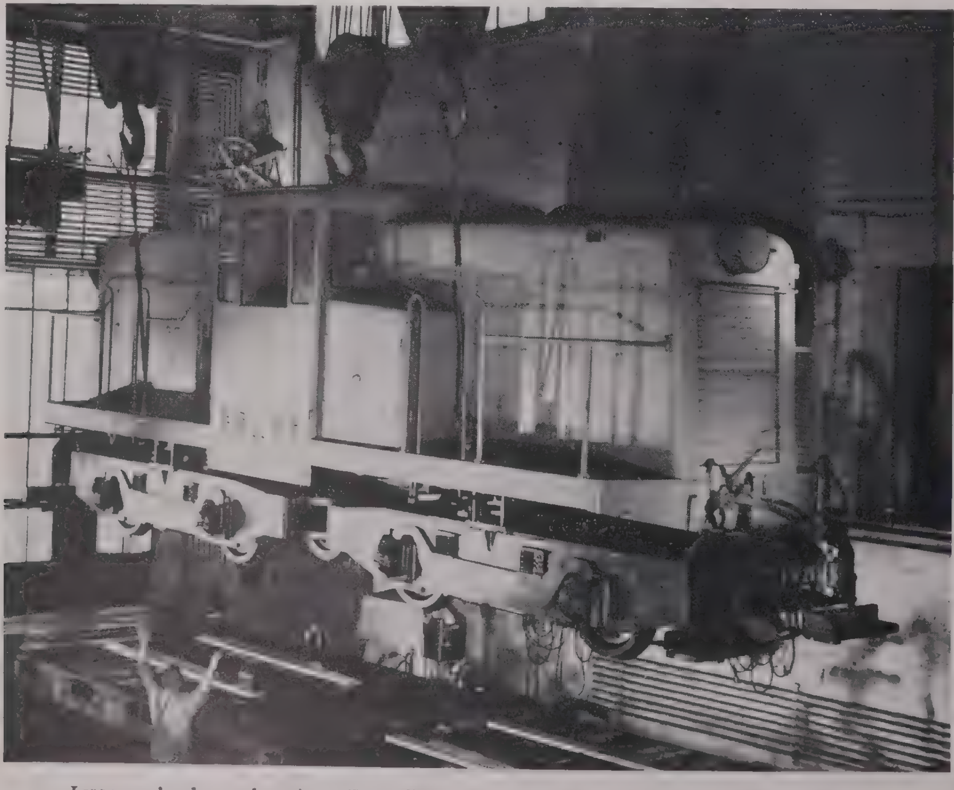
*This and the other photographs in this article are production stills from General Electric's new full-color and sound motion picture "Materials Handling—In Receiving, Warehousing, and Shipping."

It seems to be an unfortunate commentary that most materials-handling men know of at least one or two cases where practically everything was considered in a new building or layout except materials handling. The result is usually a conveyor that is three times as long as it would have been if planned properly, a loading depot on the wrong side of the building, structural provision for a 15-ton crane instead of a 30, or something of that nature.

Real progress toward the solution of this problem would result from management's delegation of just as many high-caliber, analytically minded engineers to materials-handling work as are put on other programs, with delegation, as well, of enough authority to make their findings count.

Top management's assistance in developing accounting systems and procedures that determine fully just what materials-handling costs really are would also be of great value. At the present time such systems are almost nonexistent. When they are readily available, making it obvious just what it does cost to move a ton of steel from boxcar to warehouse to factory, through production to finished product, management will take more active interest in materials handling. A major revision in accounting routine would be required. The results would be startling.


A portable conveyor, or stacker, being used to move material from one floor level to the next. The stacker loads and unloads railroad cars, trucks, etc. Some can be used in a horizontal position, like a stationary conveyor


Large overhead crane lowering a 47-ton diesel-electric locomotive onto a flatcar. Used also in warehousing for moving heavy loads, the overhead crane is of particular value where lack of aisle space prevents or hinders the use of floor-stationed equipment. Such systems can be supplemented by and integrated with conveyor, truck, and tractor systems

Standardization

Then there are the problems of simplification and standardization of methods and equipment. Every industrial engineer can cite examples of savings and increased production through standardization in factory processes. Yet an almost complete lack of standardization in materials-handling technique and equipment prevails today, not only within industries but within different plants of a single company, and often between buildings in the same plant.

The problems connected with the use of unit loads is important. Valuable as they are, unit loads often are not used in applications where they could be profitably employed. Flow charts are still too much of an academic novelty in some operations. And the increased use of automatic processing machines is at the same time a solution to one materials-handling problem and the introduction of another, since provision must be made for the supply of more raw material to the machine, the removal of the finished part, and the removal of scrap. This, in turn, goes back into the old problem of plant layout, door widening, aisle widening, storage areas, etc.

Problems of Equipment

Battery-operated trucks of various types are the solution to many materials-handling operations, but servicing, such as battery charging, constantly enters the picture. Just what kind of battery chargers should be used, how many are needed, and how to train workers to use them, are all questions that become increasingly important.

The more pieces or pounds moved in a single handling operation, the lower the cost and the shorter the time required to move any given volume. A battery-operated fork truck, used in palletized storage operations, picks up and carries a unit load of 10,000 to 12,000 pounds in one handling

Even when the product has been completed and is ready to leave the warehouse, most of us find that our problems are by no means ended. Pallets are becoming more and more important. They must be strong, light in weight, and yet low enough in cost that they do not add much to the overhead cost that is always one of materials handling's chief headaches.

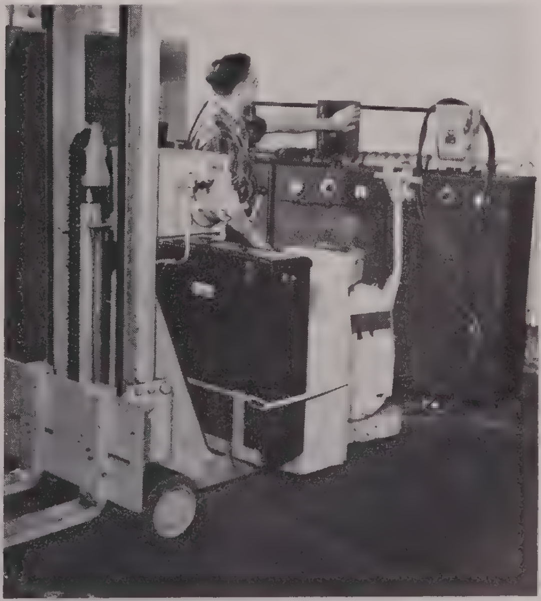
When the railroad industry was in its infancy, the restrictions on the use of boxcars was one of the great barriers to effective freight shipments. It is probably safe to predict that some day pallets will flow as freely between shippers as boxcars do, and interstate, intercompany, and interdepartmental boundary barriers will be eliminated. Expendable or more durable pallets may provide an answer to this problem.

Since materials handling is at once pure overhead and an indispensable part of any company's operations, the obvious thing to do is to keep its cost as low as possible through the use of the most modern equipment available.

Materials-handling engineers in large plants or companies have faced the problem of equipment in one section of the plant being rushed while equipment in another section is idle. In some cases this means keeping a much larger truck force than necessary, just to accommodate these chance peak loads. One solution may be the use of short-wave radio on trucks, tractor trains, etc., so they can be summoned quickly to the congested area.

Many of these materials-handling problems might also be solved through the effective application of time and motion studies with the same degree of intensity with which they are applied to other manufacturing operations. No one quite knows what the savings might be if this were done, because it has never been tried to any great extent. Whenever such studies have been made, however, the results have been well worth the trouble and expense. The integration of materials handling into plant layout, through the use of scale models in the preliminary stage, has produced results well known to everyone in the field.

One of the means by which industry as a whole has advanced to its present high standard is research. Why not a complete research institute or building for materials handling? Then actual machines could be set up, tractor trains brought in, conveyors installed, ramps built, and storage areas planned to make sure the most effective technique and equipment are used. It would be well worth the cost by providing the best solution to many problems of the types that have been referred to in this article.



Copper-oxide battery charger being used to charge batteries of a fork truck between periods of active service. This charger is fully automatic and easily installed and operated; it can be moved from one location to another with ease, and requires but little maintenance

No Space to Spare

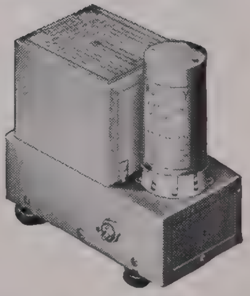
So this MALLORY *Self-Rectifying* VIBRATOR came to the rescue

The vibrator power supply unit pictured above was developed and built by Mallory for mobile equipment and field use. Measuring less than 7″ x 4″ x 4″, it *had* to economize on parts—and it did!

The Mallory self-rectifying vibrator, shown beside it, was the part that especially turned the trick. A pretty small vibrator to begin with, *it eliminated the need of a rectifying tube.*

What's more, this vibrator was rugged and dependable. It stood up under a lot of bouncing around—"took" the gaff of weather extremes.

Do you have a product where vibrator compactness and dependability are important requirements? Call on Mallory—"Vibrator Headquarters." Begin by contacting the nearest Mallory field representative. Or write direct for the comprehensive Mallory Vibrator Questionnaire.



MALLORY VIBRAPACK* POWER SUPPLIES

Mallory Vibrapacks deliver voltages from 125 to 400 from low voltage sources . . . with high efficiency, low battery drain, ease of installation, long life.

*Reg. U. S. Pat. Off.

P. R. MALLORY & CO. Inc.

MALLORY VIBRATORS AND VIBRATOR POWER SUPPLIES

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

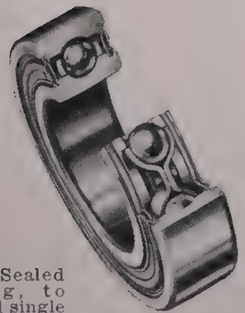
More Mallory Vibrators are in use today than all other makes combined

New Departure
ENGINEERING SERVICE
PART FOUR
—
BEARING LOAD
COMPUTATION

Four books up—and two to go. Four new books in the engineering series for the designer on the royal road to good bearing performance.

Part Four provides a new, simplified version of bearing load computation. In addition to consideration of the general sources of loads and bearing reactions, it includes a particularly useful treatment of the loads due to various types and arrangements of gears.

Mailed gratis to engineers and designers. Please use your company letterhead and ask for booklet LC.



Nothing Rolls Like a Ball

NEW DEPARTURE

BALL BEARINGS

19

Double Sealed bearing, to standard single row width. One of many available types.

NEW DEPARTURE • Division of GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT • BRANCHES IN ALL PRINCIPAL CITIES

A VERSATILE A-C LOAD VISUALIZER

Unusual circuit combines in a single instrument means for determining load characteristics the measurement of which previously has required the readings of several conventional instruments

By P. J. WALTON
Engineering Division, Atlantic District
Apparatus Department, General Electric Company

P J Walton

THERE has been developed a lightweight, compact instrument for measuring a-c load, enabling kilowatts, amperes, and volts, as well as power factor, to be determined without the need for other instruments. The conventional instruments used for this purpose—wattmeter, ammeter, voltmeter, and power-factor indicator (when used)—are a bulky and heavy group, and therefore not readily portable for making tests in a number of locations.

Theory

The principle on which the instrument operates is illustrated in **Fig. 1.** This diagram shows the vector relationship between the line current in a three-phase circuit, its in-phase or power component, and its wattless or reactive component. Since the reactive component in conductor *C* is in phase with the voltage across conductors *A* and *B*, it can be neutralized by a current produced by voltage *A-B*. In this way, a direct reading of the power component of the line current can be obtained.

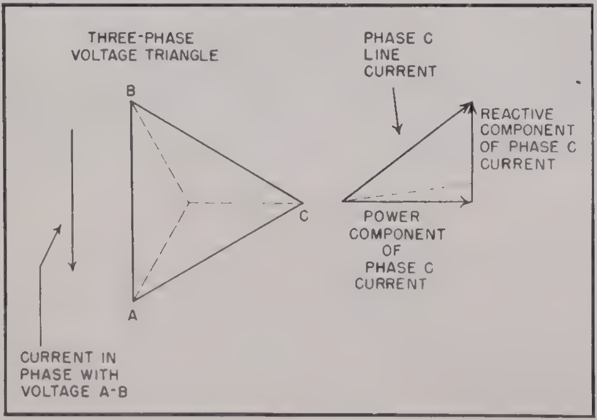

THREE-PHASE VOLTAGE TRIANGLE
B
C
A
CURRENT IN PHASE WITH VOLTAGE A-B
PHASE C LINE CURRENT
REACTIVE COMPONENT OF PHASE C CURRENT
POWER COMPONENT OF PHASE C CURRENT

Fig. 1. Vector relationship in a three-phase circuit. Current produced by voltage *A-B* is used to cancel reactive component of current flowing in Conductor *C*

Fig. 2 is a diagram of connections showing an ammeter connected to read the current in conductor *C*. It also shows a reversing switch in the leads from conductors *A* and *B* and a resistor for varying the amount of current taken from phase *A-B*. Adding these two currents, the ammeter will read the vector sum. The polarity should be such that the vector difference is obtained. The phase rotation determines which polarity should be used.

If the resistance is adjusted until the reactive component is neutralized, the ammeter will read only the power component of the current. Since the power component is the smallest value of current for a given amount of electrical energy, the minimum reading on the ammeter is the power component.

As the minimum reading is approached, as indicated by the dotted line in **Fig. 1,** it is seen that a considerable amount of reactive component makes very little difference in the reading. Thus a very accurate vernier method of obtaining the minimum reading of the instrument is provided.

First Test

This new method was compared with conventional instruments by connecting two single-phase wattmeters in a three-phase circuit. Also connected was an ammeter, in accordance with **Fig. 2,** and a voltmeter.

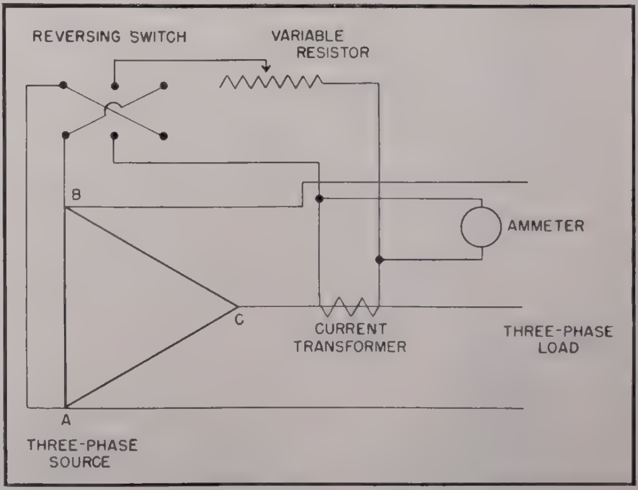


Fig. 2. Diagram of connections for obtaining the power component of line current

A low-power-factor three-phase balanced load was used. The first readings of the wattmeters showed only half as much power as that calculated from the ammeter and voltmeter readings of the visualizer. This resulted in finding that the common potential lead to

---

This article is so paged that, without mutilating other articles, in can be readily removed for filing as a group of full-size consecutive pages.—Ed.

the wattmeters was not making contact and that the potential coils were operating in series and at half voltage, an error that probably would not have been discovered with the wattmeters only.

In this test, on a commercial power circuit and therefore with about an average amount of unbalance in voltage, the difference in the results obtained with the new method and with the wattmeters was only about one per cent.

Sample Instrument

After the initial tests, a sample instrument was built. A phase shifter was used to obtain any desired power factor. The average error of three readings was only one quarter of one per cent.

In the original arrangement, the load current and the out-of-phase current were added vectorially by connecting these two currents in multiple. For design reasons, this arrangement was changed to a current coil and a voltage coil, thus adding the two currents magnetically, both coils acting on the same iron-vane moving element. The current winding is electrically insulated from the imposed voltage by an internal current transformer.

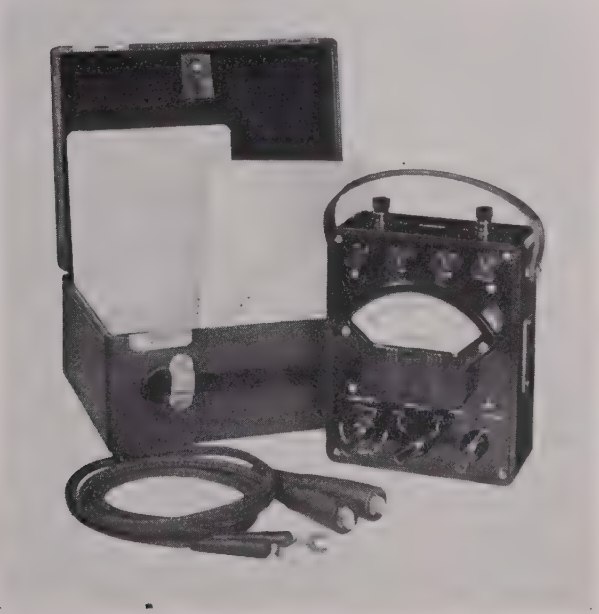


Fig. 3. The load visualizer removed from its case. The calculator, a reconstruction of the vector diagram, is to the right in the case

When only one of the coils is energized, the voltage is read. When only the other coil is energized, the line current is read. When the visualizer is connected in a three-phase circuit with both coils energized and with the adjustment to obtain the minimum reading, the power component of the current is read.

For General Use

Since then, an instrument for general use has been developed having the appearance as shown in **Fig. 3.** It is relatively small in size and light in weight, comparing favorably with an a-c ammeter, and is therefore readily portable. The internal connections are shown in **Fig. 4.**

It can be used up to 600 volts without a potential transformer and above that voltage requires only one. It is rated 2½ or 5 amp but above that amount of current or above 600 volts requires only one current transformer, even for three-phase circuits.

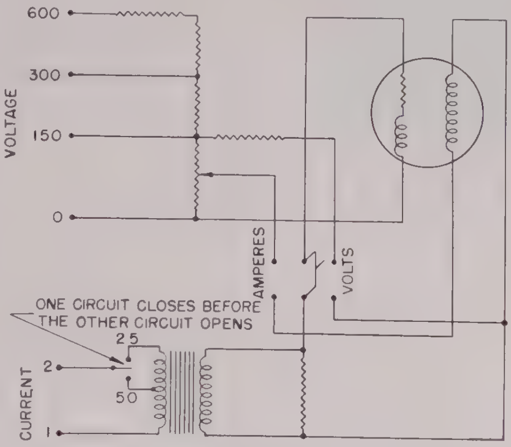


Fig. 4. Internal connections for the visualizer

If it is not desired to read the heavy current taken by a motor at starting, the switch can be turned to read volts when the motor is being started.

A simple calculator is furnished with each instrument to facilitate operation. This calculator, shown in **Fig. 3,** is a reconstruction of the current vector diagram. The movable arm represents the line current and is pivoted at the left.

If, in a three-phase circuit, a line current of five amperes and a power component of four amperes have been read, the five-ampere point on the movable arm of the calculator is set on the vertical line corresponding to four-ampere power component, and the movable arm points to the power factor—in this case 80 per cent. At the right, the reactive current is read—in this case, three amperes.

Operation

After taking the voltage reading and the ammeter (line-current) reading, the knob on the adjustable rheostat is turned from the off position. If the current reading increases, the instrument is connected with the voltage-coil polarity reversed. All that is then necessary is to reverse the potential leads. Then when the rheostat knob is again turned from the off position, the reading decreases as the knob is turned, and the operator reads the minimum current value obtained.

The instrument can also be used in a single-phase circuit or combination of single-phase circuits, such as two-phase or six-phase. In the case of a single-phase circuit, current in-phase with the one voltage available is used to neutralize the power component of current and the reactive component is read directly.

In a three-phase circuit, the usual method of obtaining the volt-amperes is to multiply the amperes by the volts by 1.73. The kva is obtained with the visualizer in the same way; power factor is equal to the power component of the current divided by the line current; and the kva multiplied by the power factor is the kw. An alternate method is to multiply the power component by the voltage by 1.73 to obtain watts.

From the three direct readings obtained with this one instrument—the volts, the amperes, and one of the components of the current—the other component is determined, obtaining all of the values needed for measuring an a-c load—volts, amperes, watts, vars, and power factor.

In general, the load visualizer is intended for use on single-phase and balanced polyphase systems. Only one set of readings is then necessary. Under unbalanced current conditions, readings of line and component current should be taken for each phase.

The set of instructions and calculator provided with the instrument make possible its operation by nontechnical personnel. Because of its portability and ease of making connections, the instrument is advantageous for quick testing.

All readings are made on a single dial. In a three-phase circuit, the current of only one phase is used, and the voltage terminals are connected to the other two phases. This is very easy to remember, especially compared to a polyphase wattmeter, in which, it has been stated, there are 94 possible connections, only four of which are correct. If the polarity is wrong, the visualizer tells the observer; instead of obtaining a minimum current reading, the reading increases when the out-of-phase current is introduced.

It is difficult for the average electrician to use a polyphase wattmeter or two single-phase wattmeters with confidence in the results because there are too many chances of error in the connections. This leads to errors and uncertainty of results when making field tests.

The light weight and simplicity of the visualizer, and the fact that it actually tells the operator whether or not he has it connected correctly, are points very strongly in its favor. A number of advantages are as follows:

(a). The connections are simple and avoid the errors which may easily be made when using polyphase wattmeters.
(b). It is small, lightweight, and easily portable, much more so than a set of conventional instruments.
(c). It has a lower price than a complete set of instruments for obtaining the same information.
(d). It can be used on any single-phase or balanced polyphase a-c circuit.
(e). It uses only one current transformer.
(f). There is only one dial to read.
(g). It is five instruments in one—measures volts, amperes, watts, vars, and power factor.

Uses

The visualizer has been found to be very useful i practice. One user had to read the loads taken b motors in a ship which would be at the dock only a da or so each voyage. Walking down the ladder into th engine room of a ship carrying the visualizer in on hand simplified what would have been the difficult tas of carrying a polyphase wattmeter, ammeter, an voltmeter. By means of simple equipment and connections, the load and power factor of the various motor was readily checked and all the necessary readings obtained quickly and accurately in the time available He reported that in a laboratory test the visualize read within one per cent of the results obtained wit a wattmeter.

In a 180-cycle substation, the switchboard include only one current transformer in each of the four circuits With the visualizer, readings of watts and powe factor were obtained which could not have been obtained with any other available single instrument. A power-factor indicator uses only one current, but as i has little torque at low loads, may not give accurat readings under that condition. In practice, readings o a power-factor indicator and wattmeter are not use to obtain kva, but rather the readings of amperes an volts.

When a laboratory was having difficulty readin power at 10,000 cycles, a point where wattmeters become unreliable, use was made of the principle of th visualizer successfully to obtain readings of power a that high frequency. (It should be noted, however, tha the visualizer itself is limited to 60-cycle operation.)

The visualizer can be used for load surveys, induction-motor tests to find out whether the motors are o proper size for the application, and power-factor studie on power and lighting circuits. Our old conception tha lighting is at unity power factor has been changed b the fluorescent lamp, which, without correction, ma have a power factor of about 50 per cent.

The instrument should not be used with the ordinar split-core current transformer, for the reason that suc a current transformer does not have as good a magneti circuit as one in which the core is not split and therefore has a phase-angle error which cannot readily b calibrated out, as can its ratio error. If, on the othe hand, the split-core current transformer is of the interlocking-joint construction to reduce magnetic reluctance, the error may be negligible. The same comment of course apply to the use of a split-core current transformer with a wattmeter, since the same type of erro is obtained in either case.

The visualizer provides a novel means of studyin the vector relationship between the components of a a-c current and of obtaining a better understanding o power factor. It should, therefore, be useful also t students in electrical schools and colleges.

The convenience afforded by this instrument will b welcomed, particularly by the electrician, who is interested in obtaining the desired data with a minimum o wiring complexity.

A-C MOTOR DRIVES FOR MODERN ELEVATORS

Some of the qualifications for satisfactory drives and how the squirrel-cage induction motor is used to meet these requirements

By M. A. de FERRANTI
Industrial Engineering Divisions, Apparatus Department
General Electric Company

INDUCTION motors have long been used as one means of driving passenger and freight elevators and will continue to have a very important place n this field. The qualifications necessary for a satisfactory elevator drive can best be understood by a brief review of modern elevator practice.

Mechanical Arrangement

Early designs of electric elevators used a hoisting mechanism consisting of a winding drum, driven through gearing by an electric motor. However, this type of drive was subject to overwinding, and some nstances of very serious accidents are recorded as resulting from the failure of overtravel protective devices. Modern elevators use traction drive which eliminates the overwinding hazard because of the loss of traction when either the car or the counterweight bottoms on its buffer. Such a drive (**Fig. 1**) lends itself to the use of multiple ropes without requiring excessively large driving sheaves. In **Fig. 1**, the wire ropes from which the car is suspended pass over the driving (traction) sheave around the idler sheave, back around the traction sheave, and finally over the idler sheave again to the counterweight. The "double wrap," as this method of roping around the driving sheave is named, is necessary to provide sufficient traction when U-shaped grooves are used on the sheave face. By the use of V-shaped, or modified V-shaped, grooves it is possible to increase the friction between the hoisting cables and the driving sheave so that adequate traction is obtained by a "single wrap" around the driving sheave. Both types of grooving are in common use, and each has its advantages and disadvantages.

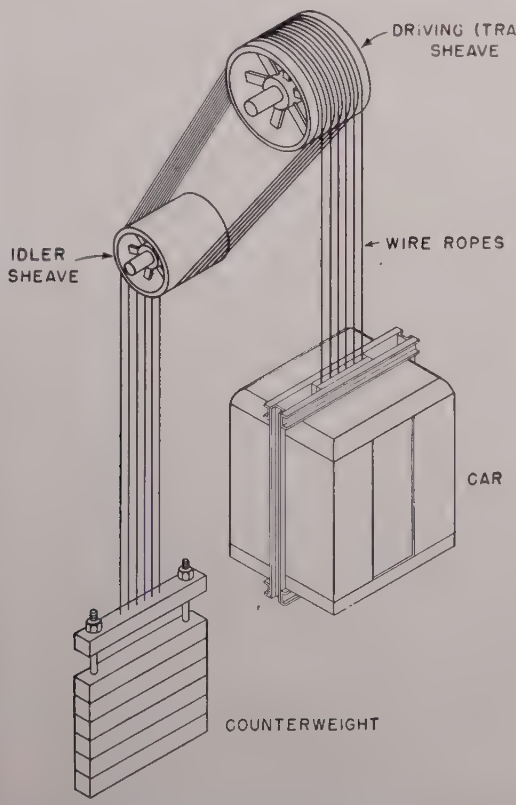


Fig. 1. Diagram of the modern traction drive, employing the double-wrap method of roping

The choice between types of grooving involves such factors as traction, quietness of operation, bearing loads, rope-life, sheave material and life, length of ropes and simplicity of construction. The hoisting system shown in **Fig. 1** uses 1:1 roping, in which the car travels at the same speed as the ropes, and the net pull in the ropes is that which acts on the car. Similarly, a 2:1 roping system is frequently used for relatively low-speed high-capacity elevators and results in a car speed equal to half the rope speed and a hoisting force of twice the net rope pull acting on the car. In such a system the ropes are dead-ended at the top of the shaftway. The ropes pass around a sheave on top of the car and then around a sheave on the counterweight. In a limited number of very-high-capacity low-speed elevators, 3:1 roping systems have been used.

Modern practice uses wire ropes in sizes ranging from $\frac{1}{2}$ in. to $1\frac{1}{16}$ in. in diameter, with stranding either 6×19 or 8×19 wound on a hemp center. These are used with several in multiple—typically four, six, or eight—to provide a high factor of safety. Sheave sizes are dictated by the requirement of long rope life. The diameter should not be less than 40 times the rope diameter, and in practice this figure would be kept at 48, or even higher. As an example, a 150-fpm elevator using $\frac{5}{8}$-in. diam wire ropes would use a 30-in. diam driving sheave; and, corresponding to rated elevator speed, the driving sheave would run at approximately

---

This article is so paged that, without mutilating other articles, it can be readily removed for filing as a group of full-size consecutive pages.—ED.

19 rpm if the roping system were 1:1, or 38 rpm with a 2:1 roping system.

If the driving sheave of such an elevator were mounted on the motor shaft—that is, a gearless motor—it would require a physically large low-speed motor. Also, it must be remembered that in addition to operating the elevator at rated speed in either the up or down direction with positive or negative load in either direction of travel, it is necessary to operate the elevator at a very much reduced, but definite, speed to make accurate stops at the landings served. Accurate landings require that this reduced speed be not greater than 25 fpm. In the example cited in the foregoing, this means one sixth of the rated speed.

For operation of high-speed elevators, the d-c "gearless elevator motor" has been developed and combines an armature, driving sheave, and brakewheel on one shaft. However, it is not practical to use motors of this design for 1:1 roped elevators having rated speeds less than 400 fpm, and even at speeds in the vicinity of 400 fpm it is sometimes more economical to use 2:1 roping and a higher-speed gearless motor. Nevertheless, gearless-motor speeds usually fall within a range of 60 to 150 rpm corresponding to elevator speeds of 400 fpm and higher. These requirements, as well as the need to operate at reduced speeds, either motoring or regenerating, make it impractical to design a-c induction motors for use as gearless traction machines. For elevator speeds below 400 fpm, it is normal practice to use a geared drive, in which a moderately high-speed motor drives the traction sheave through a reduction gear unit. The majority of geared elevator machines use a worm and gear drive, which is suitable for the large reduction ratio and also provides smooth, quiet operation. Such a machine is shown in **Fig. 2**.

Power Requirements

Some knowledge of the power requirements of these drives is necessary before further consideration is given to driving-motor characteristics.

The counterweight, as shown in **Fig. 1**, is made of sufficient weight to equal the weight of the empty car plus about 40 per cent of the rated load of the elevator. For example, an elevator having a rating of 2500 lb may have a car weighing 4000 lb and should therefore have a counterweight of $4000+(0.4\times2500)=5000$ lb. The horsepower required to hoist full load at rated speed in an elevator is given by the formula:

$$Hp=\frac{0.6\times L\times S}{33000\times E}$$

in which

L = rated elevator load in lb

S = rated elevator speed in fpm

E = mechanical efficiency from motor shaft to elevator car

The factor 0.6 assumes the normal 40 per cent counterweighting.

The efficiency factor E varies; but an average figure for gearless elevators is 0.80, and for modern geared elevators may be as low as 45 per cent for very-low-speed elevators to 65 per cent for the highest economical elevator speeds for geared installations. A conservative average value is 55 per cent for geared machines.

In the foregoing example, assume that the elevator has a rated speed of 300 fpm; the horsepower required to hoist rated load is then 24.4. In this example the net weight to be hoisted when the elevator is carrying its rated load is 1500 lb $(=0.6L)$. However, the total weight of the moving parts in the elevator shaftway, excluding ropes and trailing cables, is 11,500 lb $(=4000+2500+4000+(0.4\times2500))$. Assuming an average accelerating rate a of 4 fpsps for the elevator, the force necessary to accelerate the moving parts would be approximately 1435 lb $(=11{,}500\times a/g$ in which g is acceleration due to gravity). This force, in addition to the 1500 lb, means a total net rope pull of 2935 lb to accelerate the loaded car in the up direction, or about twice the pull required to hoist the loaded car at constant speed. Taking into consideration the elevator ropes and rotating parts increases this ratio. Actual practice is to design elevator motors with starting torque in the order of 250 per cent of their full-load running torque.

Operating Requirements

Now, it is possible to consider the following desirable operating conditions of an elevator drive as they affect the characteristics of the motor:

(1). A high degree of reliability is expected of any elevator drive because, apart from the annoyance and inconvenience caused by passenger elevator breakdowns, such incidents represent a hazardous condition in modern buildings and are so regarded also by State and City safety regulations.

(2). Elevators located in office or apartment buildings, and particularly in hospitals, are required to be quiet operating.

(3). Speed of travel of a full or lightly loaded elevator car either in the up or down direction of travel should be approximately the same.

(4). Elevator car must slow down and stop from either direction of approach. The car floor level must agree closely with that of the landing when the car is stopped.

(5). The riding qualities of the elevator car during starting, running, and stopping must be such as to cause no discomfort to passengers.

(6). All parts of the drive must be suitable for frequent starting and stopping, corresponding to "floor-to-floor" runs.

(7). Power consumption of the elevator drive should be low.

The power supply to most city buildings now, and especially to new buildings, is from a three-phase 60-cycle network. If a d-c motor is used for the elevator drive, as in the case of the gearless machines, a-c/d-c conversion equipment must be installed. This is usually an individual motor-generator set for each elevator, with the machines operating as an adjustable voltage (Ward Leonard) system. The same system is used for geared elevators having d-c drive motors, which combination of machines is a particularly common application for geared elevators with rated speeds below 400 fpm.

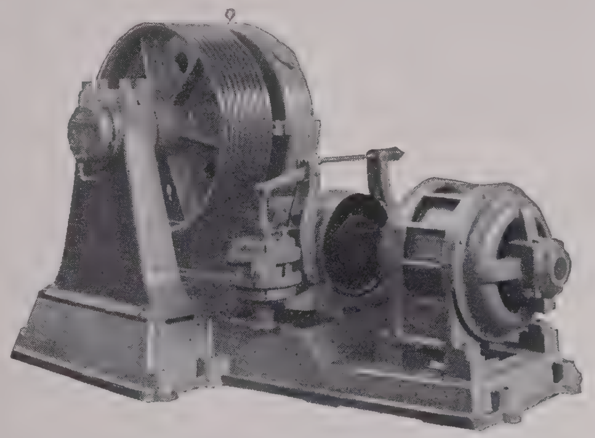


Fig. 2. A geared elevator machine in which the motor drives the traction sheave at a reduced speed through a worm-and-gear unit

Single-speed A-c Drives

Induction-motor drives of geared elevators eliminates the use of rectifier equipment or motor-generator sets and has a very important place in passenger and freight elevator applications. Reviewing the operating conditions of elevator drives readily indicates that a general-purpose induction motor is unsuitable for this application because of its comparatively low starting torque.

Also, it is clear that a single-speed squirrel-cage induction motor has a limited range of application to low-speed elevators because of the absence of a positive reduced speed of operation.

However, slowdown methods using partial setting of the brake have been devised, and the single-speed a-c motor is extensively applied on elevators having speeds of 50-100 fpm and, in some cases, as high as 150 fpm. For this application, high-starting-torque motors specially designed for quiet operation and suitable for frequent starts are used.

The full-speed running time of elevator motors is very small, but most of the heat developed in the motor is due to frequent acceleration of the total inertia in the drive. Normally, for an a-c single-speed motor drive, the inertia external to the motor is approximately equal to the internal inertia in the motor. The cooling problem with this type of motor is accentuated because full ventilation is available only during the short time at which the motor runs at full speed.

Single-speed motors designed for these applications are capable of making 125 elevator starts per hour (including jogging) under the conditions described. They are capable of developing a starting torque of approximately 250 per cent of full-load running torque. This value is adequate for accelerating the fully loaded elevator in the up direction, but when applied to a partially loaded elevator would develop excessive rates of acceleration. Therefore, it is normal practice to use at least one step of primary resistance in the control equipment for such drives. By these means the torque is applied gradually and, regardless of loading, the elevator is started smoothly.

Speed-torque characteristics for an a-c single-speed high-resistance motor are shown in **Fig. 3**. Curve *A* shows full-voltage characteristics, and Curve *B* shows the characteristics with sufficient primary resistance included to reduce starting torque to 125 per cent of full-load torque. With the lowering of a fully loaded car or the raising of a lightly loaded car, overhauling torque is imposed on the driving motor. In making landings with this type of drive, all of the kinetic energy in the moving parts of the elevator drive must be dissipated by the brake.

Curve *C* in **Fig. 3** shows the full-voltage speed-torque characteristics of an a-c single-speed low-slip type elevator motor, which is a cast-aluminum-rotor type machine now manufactured in sizes up to 20 hp at 1800 rpm. This high-torque low-starting-current motor has a slip of three to four per cent at full load, assuring good speed regulation on elevator drives. The full-load speed value also agrees closely with the standard full-

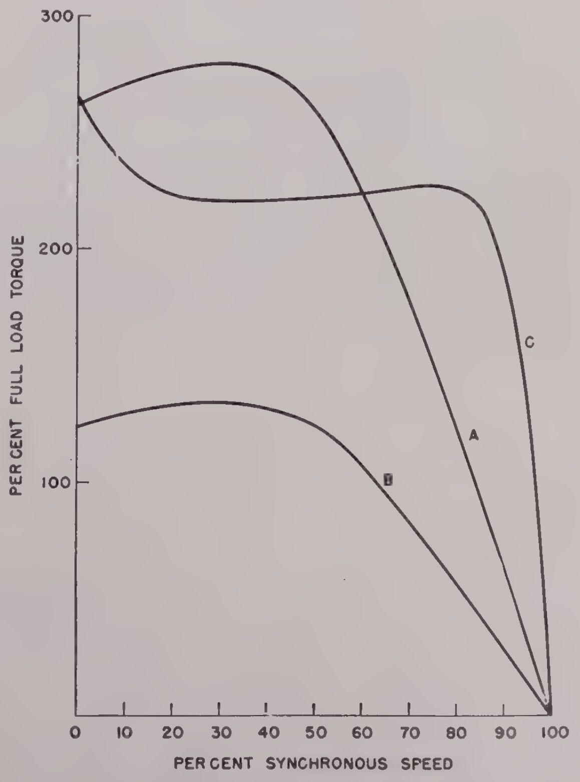


Fig. 3. Speed-torque curves of a single-speed high-resistance induction motor: Curve *A* shows the full-voltage characteristics; Curve *B* shows the characteristic with primary resistance inserted to reduce starting torque to 125 per cent of full-load torque; and Curve *C* is the full-voltage characteristic of a single-speed low-slip type

load speed ratings for d-c motors, 850 rpm, 1150 rpm, or 1750 rpm. In some instances this allows the elevator manufacturer to minimize the number of gear ratios used to cover a complete line of a-c and d-c geared elevator machines.

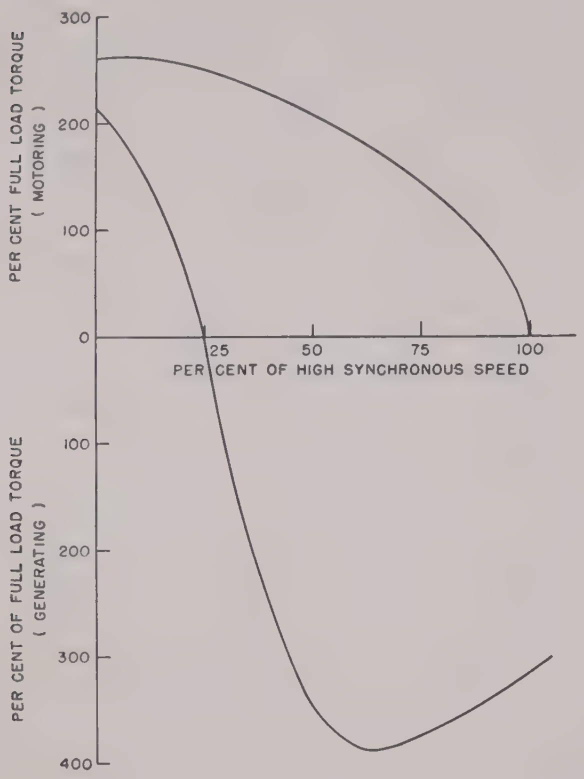


Fig. 4. Speed-torque characteristics of a two-speed induction motor

Two-speed A-c Drives

The two-speed squirrel-cage motor considerably extends the range of elevator speeds over which a-c motors can be successfully applied. The two speeds of the motor are obtained by the use of separate windings superimposed in the same stator slots, making it unnecessary to disconnect the motor from the line during transition from one speed to the other. With this design of motor, common ratios between high and low speed are 2:1, 3:1, 4:1, and 6:1, with synchronous speeds of 1200 or 900 rpm for the high-speed windings. The speed-torque characteristics of a typical a-c two-speed elevator motor are shown in **Fig. 4**. Normal practice is to start on the high-speed winding, providing for smooth acceleration up to full speed, without transition. As in the case of single-speed motors, the high-speed winding of the two-speed motor is designed to develop about 250 per cent starting torque. Primary resistance is used in the control system to assure smooth starts under all conditions of loading of the elevator car. Slowdown is secured by transferring to the slow-speed winding in the following manner:

(1). With the high-speed winding still connected to the supply, the low-speed winding is connected to the supply through a resistor

(2). The high-speed winding is then disconnected, and the resistance in series with the low-speed winding is short-circuited.

These steps are controlled by timing relays adjusted to values which give smooth transition for each specific installation. While slowing down from the high speed to the low speed, part of the kinetic energy in the moving parts of the elevator drive is returned to the power-supply system through the regenerative action of the low-speed winding of the motor. The brake is then called on to dissipate only the energy remaining in the system when operating at the low speed. The kinetic energy varies as the square of the speed; therefore, with a 4:1 motor the kinetic energy in the system at the low speed is only one sixteenth of that at the high speed. Thus, brake wear is greatly reduced.

Two-speed elevator motors should be so selected that the horsepower rating of the high-speed winding is not less than the horsepower required to hoist the car with rated load. This type of motor, because of the special windings, is physically larger than a single-speed motor of the same horsepower rating, and as a result the motor inertia is generally larger than the external inertia. However, experience indicates that this type of motor can make 150 starts per hour (including jogging) without excessive temperature rise. This is satisfactory for most installations. But there are cases where elevators stop at every floor, and a self-ventilated two-speed a-c squirrel-cage motor will overheat under these conditions.

A special forced-ventilated form of the two-speed a-c squirrel-cage elevator motor has been developed for use on installations where the elevator will start more frequently than a rate of 150 per hour. Tests on this type of motor indicate that it will handle, without excessive temperature rise, 300 starts per hour when driving a load with inertia equivalent to that on a normal elevator drive. Such a motor is shown in **Fig. 5**. The fan runs continuously, thus providing full ventilation during acceleration, slowdown, and standing time of the motor. The air from the fan is so directed that it

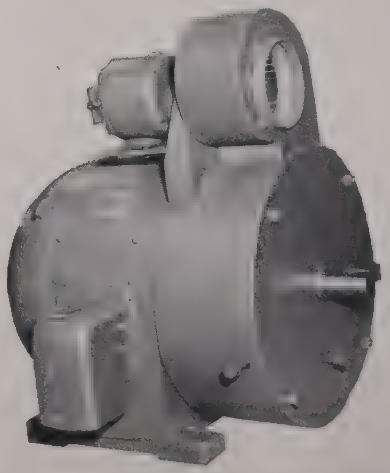


Fig. 5. A two-speed squirrel-cage motor having special forced ventilation enabling 300 starts per hour without excessive temperature rise

passes over the end windings (rotor and stator) at the drive end of the motor, then axially along the outside of the stator punchings, over the end windings at the front end of the motor, and is then exhausted.

An alternative method of handling severe duty-cycles of the type described is to use a tandem motor consisting of a low-speed squirrel-cage motor and a high-speed wound-rotor induction motor built as a single unit. An installation in which drives of this type are used is shown in **Fig. 6**.

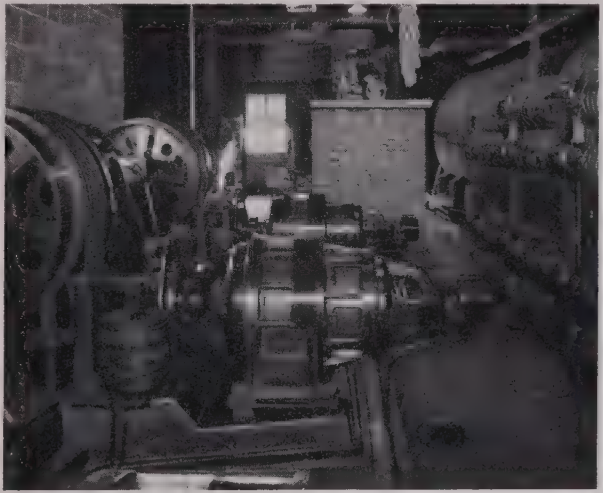


Fig. 6. An installation of two-speed tandem induction-motor drives

Enclosed a-c single-speed motors are particularly applicable to elevators installed in locations where damaging fumes or dust are present. For such conditions, the motors are built as totally enclosed nonventilated machines to meet the Underwriters' requirements for Class II, Group G or for Class I, Group D conditions. The enclosed motor will depend on radiation only for dissipation of the losses produced in it by repeated starting and running of the elevator. Experience indicates that under average conditions about 70 starts per hour can be made without excessive temperature rise in the motor. Nothing is to be gained by adding fan cooling on the enclosed motor, if the fan is driven by the motor shaft, because full air flow from the fan will only be developed for part of the operating time of the motor, and the inertia of the fan will cause additional losses in the motor.

SEXTON CAN COMPANY
Incorporated
Everett Massachusetts
Manufacturers of
Ash Barrels
Kitchen Waste Cans
Underground Garbage Receivers

CAPACITOR CASES
both Fabricated and Deep Drawn
FIVE GALLON
Open and Closed Top Shipping Containers

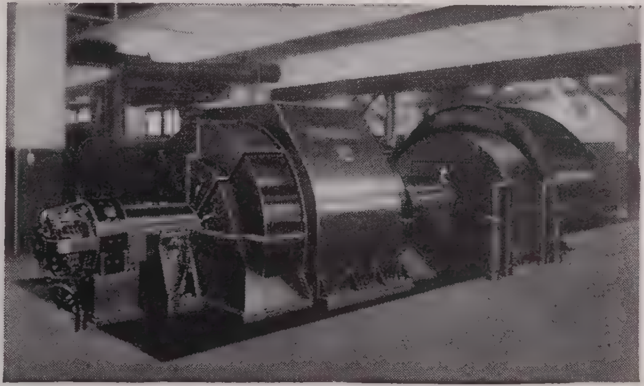
METAL STAMPINGS
SPECIAL SHEET METAL WORK

Plug-in RESISTORS

★ Clarostat Series BT and SBT plug-in resistors are solving the problem of an economical voltage-dropping resistor and source of pilot lamp voltages in many AC-DC radios. Also used in other electronic assemblies. Perforated metal housing for handling higher power ratings than the metal-tube Series MT. Made to your exact requirements.

★ Write for Bulletin 107. Engineering collaboration and quotations on request

CLAROSTAT Controls and Resistors
CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.


9,000 hp Synchronous Motor, manufactured at C-G-E Peterborough Works, driving a centrifugal compressor at a large Canadian nickel mine.

In Canada . . .

ten factories manufacture General Electric products. 30 engineering and sales offices and 19 warehouses are located from coast-to-coast to serve you.

CANADIAN GENERAL ELECTRIC CO
LIMITED
Sydney • Halifax • Saint John • Quebec • Chicoutimi • Trois Rivieres • Sherbrooke • Montreal • Ottawa • Toronto
Hamilton • St. Catharines • London • Windsor • Noranda • New Liskeard • Sudbury • Timmins • Fort William
Winnipeg • Brandon • Regina • Saskatoon • Lethbridge • Edmonton • Calgary • Trail • Kelowna • Vancouver • Victoria

HIGH LIGHTS and SIDE LIGHTS

Eye-dropper at Work in the Steel Mill

"Eye-dropper" sampling molten steel. A heat-resistant glass tube with a rubber bulb at one end sucks up a glowing sample. The steel hardens, the glass is broken away, and laboratory engineers have a smooth, even rod to test for impurities

Science has removed the eye-dropper from the family medicine cabinet and put it to work sampling molten steel at 2700 F.

The "eye-dropper," as now used industrially, is a heat-resistant glass tube, about the diameter of a lead pencil and 18 in. long, with a rubber bulb at one end. Liquid steel fresh from the furnace is drawn up into the tube by means of the rubber bulb, just as medicine is drawn by an eye-dropper. Within five minutes the steel hardens into a smooth, homogeneous rod, the glass is cracked from it, and the rod is ready to be checked for quality.

Eye-dropper samples may be prepared for analysis in a few minutes. Older techniques required long hours and involved such laborious operations as cutting a block from a hardened steel mass, machining it into a rod, and buffing it to a high polish.

Three men, wearing gloves and goggles, form a highly co-ordinated testing team. In a sequence that must take no more than 60 sec, the first man removes a puddle from the heart of the furnace with a ladle on the end of a ten-foot pole; a second worker skims away the slag forming on the surface as the metal approaches the solidifying point; and the third man then steps forward with the "eye-dropper" to suck up a glowing sample.

(Continued on next left-hand page)

Better Truck Lighting

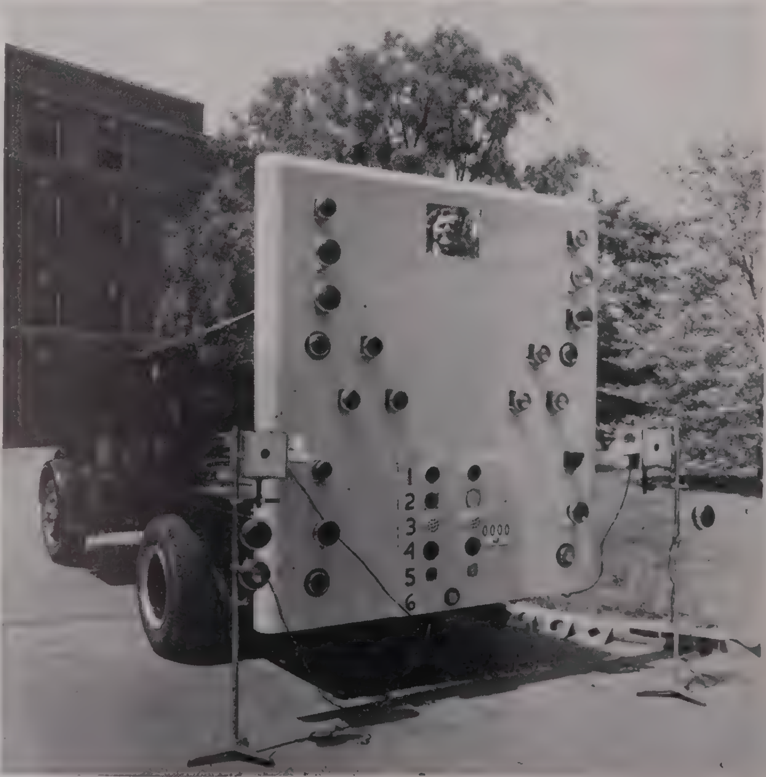
The use of more effective "stop" and "turn" signal lights for the nation's nearly 7,000,000 trucks is expected to result from studies made recently by the Society of Automotive Engineers.

More than twenty such lights—of various sizes, colors, and intensities—were viewed at distances up to 500 ft, under both day and night conditions, at a meeting of 40 automotive experts.

While final specifications were not adopted at the meeting, it was determined that the lights should be red or amber at the rear and preferably red, amber, or white at the front, that they should be at least four inches in diameter, and that they need not bear printed instructions or arrows.

One of the chief problems was that of selecting signals of sufficient intensity to be effective in sunlight, yet not so bright as to be blinding at night.

To assist the auto-lighting experts in their studies, laboratory test equipment was devised in the form of red and amber lights that were adjustable from two to eight inches in diameter and capable of intensities of 5 to 500 cp.



No truck is likely to be so well equipped with "stop" and "turn" signal lights; this panel, having ten red and ten amber lights is being used by auto-lighting experts to determine adequate standards for the nation's large trucks On either side of the panel is test equipment designed to give light of a wide variety of sizes and intensities. The operator at the porthole turns on the lights singly or in combination for inspection from distances up to 500 ft.

We take our own medicine

℞ TO MAINTAIN UNIFORM QUALITY AND PRODUCTION OF MOLDED PLASTICS

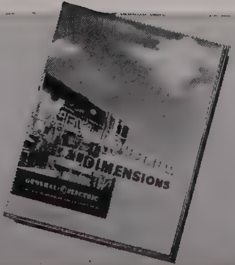
More effective control of quality . . . elimination of summer shutdowns and costly repairs of scored cylinders because of warm water . . . that's the record from a plastics plant where a G-E Condensing Unit plus a G-E Evaporative Cooler provide refrigerated water to cool cored injection molds and injection plungers. The 50 hp General Electric Unit provides refrigerated water at a constant temperature to ten injection presses in a plastics plant of the General Electric Chemical Department.

IN PLASTICS MANUFACTURE . . . as in precision machining, quality control techniques, and a wide variety of other industrial operations . . . General Electric has been active in introducing refrigeration and air conditioning systems to help speed up production and maintain quality.

Wherever heat, humidity or dust cut down *your* production speed or quality, *there's* a place for G-E refrigeration or air conditioning equipment. Call your G-E Distributor or Contractor for full information.

GENERAL ELECTRIC

Industrial Refrigeration and Air Conditioning



Get this FREE book

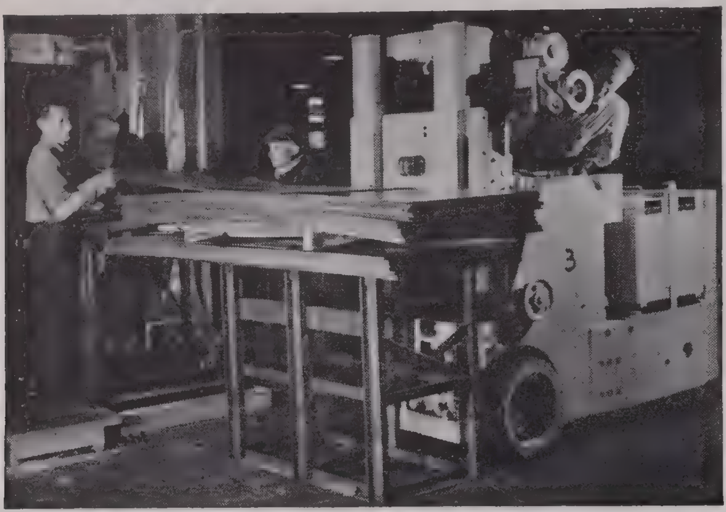
"New Industrial Dimensions" describes 17 important applications . . . gives photos and diagrams of basic heat transfer methods.

General Electric Co.,
Air Conditioning Dept., Section A8158
Bloomfield, N. J.

Please send me FREE copy of the General Electric book "New Industrial Dimensions."

Name____________________
Address____________________
City____________________State__________

Handling Work is STOP and GO



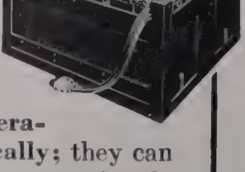
and Needs Instant-On-Off Power

In replacing a loaded skid box with an empty beside a machine, an industrial truck will make an average of approximately 14 moves forward, backward, up and down. A battery industrial truck has a natural advantage in this kind of stop-and-go service because it gets the necessary surges of power instantly from its battery, yet consumes no power during the stops. Thus it is not only economical of power, but the electricity used for charging its batteries is low-cost power.

Its electric-motor drive operates quietly, without vibration, and thus with well-nigh negligible repair requirements. With batteries exchanged two or three times per 24 hour day, it is continuously supplied with power and, since one battery is charged while the other works, the truck need not stop work for servicing of its power unit.

For 24 hour-a-day material-handling work, therefore, a battery industrial truck is an inherently dependable and economical machine, especially when powered by EDISON Nickel-Iron-Alkaline batteries. With steel cell construction, a solution that is a natural preservative of steel, and a foolproof electrochemical principle of operation, they are the longest-lived, most durable, and most troublefree batteries. *Edison Storage Battery Division of Thomas A. Edison, Inc., West Orange, New Jersey.* In Canada: *International Equipment Company Limited, Montreal and Toronto.*

EDISON
Nickel • Iron • Alkaline
STORAGE BATTERIES



IN INDUSTRIAL TRUCKS, EDISON NICKEL-IRON-ALKALINE BATTERIES GIVE YOU THESE IMPORTANT ADVANTAGES

They are **durable mechanically**; they **can be charged rapidly**; they **withstand temperature extremes**; they are **foolproof electrically**; they **can stand idle indefinitely** without injury; they are **simple and easy to maintain**.

HIGH LIGHTS (Continued)

Cut in two and fitted into sockets before a spectrograph, the sample forms two electrodes of a high-voltage arc. An electric spark jumps between the two, giving off a light which varies with the makeup of the electrodes. By breaking up this light into its component colors with a prism, trained observers are able to judge the quality of any given batch of steel sampled by the "eye-dropper."

Giant Control System for Airport Lighting

Control equipment for 342 high-intensity lights along some 30,000 ft of runways in Boston's recently enlarged Logan International Airport is under construction for installation this summer.

The new 80-kw control system will be four times as large as any series runway system now in existence. Logan Airport, located on Boston's east side along the harbor waterfront, is being expanded to provide ultimately six runways capable of handling the largest planes in operation.

Four of the runways will be lighted under the present program, but the control system will be adequate for addition of lights on the remaining two. The runways are arranged in pairs, making possible the simultaneous use of one runway for planes taking off and one for landing, both with the full advantage of high-intensity lighting.

The control system enables operators to select runways to be lighted and to vary light intensity from the maximum candlepower to about one percent of the maximum. Thus proper intensities can be selected from the control tower to produce the range suitable for prevailing weather conditions, permitting landings and take-offs without dangerous glare.

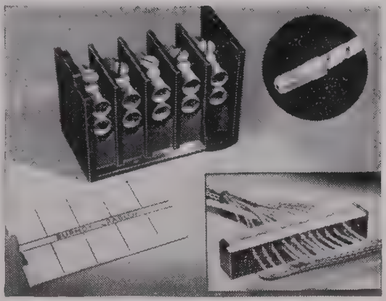
High-frequency Tube

Vacuum-tube scientists have produced a new tube which radiates as much energy as the biggest American standard broadcasting stations, at the extremely high frequency of 1,000,000,000 cycles per second.

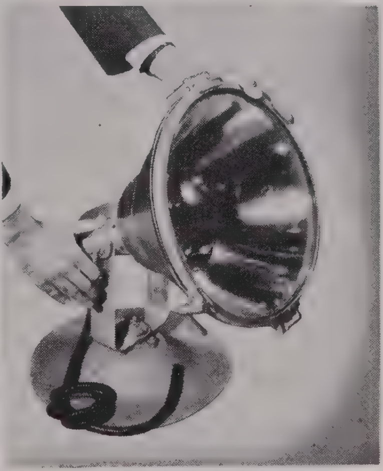
This magnetron's 50,000-watt output is the most power ever produced at the billion-cycle frequency. Frequency of the tube's output is roughly a thousand times as high as that of a standard broadcasting station. The higher the frequency, the more quickly particles in the field bump into each other, making heat by friction. Scientists are still experimenting to find out how much power can be produced at this high frequency, and the limits apparently are not yet in sight.

The magnetron tube itself is water-cooled. Unlike most conventional vacuum tubes, it makes use of an unheated cathode, which is made to emit electrons by bombardment with high-speed electrons, each of which "knocks out" three or four electrons from the cathode.

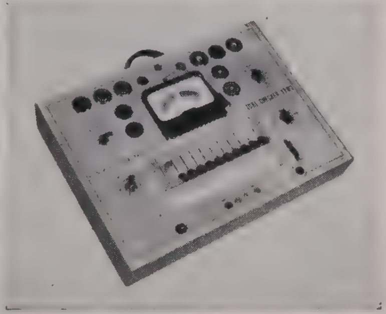
NEW PRODUCTS: AND WHAT THEIR MAKERS HAVE TO SAY ABOUT THEM



Terminal Block



Floodlight



Tube Checker

Tube Checker

A new tube checker, Type YTW-1, for rapid easy-to-read checking of receiving tubes. A large degree of flexibility is attained in the new device with each tube element having its own individual circuit switch. It tests 4-, 5-, 6-, 7-, and 8-pin standard, 5-pin small, 7- and 9-pin miniature, and locking tubes, as well as pilot bulbs and batteries. The new checker tests for filament continuity, heater cathode, open elements, shorted elements, and quality of emission. To speed up the tests of a tube, the circuit of the checker is designed to immediately expose a tube with an open filament without the usual warm-up period. This portable device weighs only 15 lb and operates from standard a-c power source.—*General Electric Co., Specialty Division, Electronics Park, Syracuse, N. Y.*

Terminal Block

A terminal block, known as the Crablok, provides for many connections in a given space, permits both rapid disconnection as well as positive locking of terminal leads, and saves time in terminating and testing. The strip is furnished in several lengths, and in either single- or double-tier types. The individual strips are placed end-to-end to provide any number of connections necessary.

In making normal quick-disconnect connections, the contact tip is inserted into the spring-loaded socket connector which grips the tip firmly and provides an efficient electrical connection. When desired, however, positive locking of the connection is quickly accomplished with a screw driver.—*Burndy Engineering Co., Bruckner Blvd., New York 54, N. Y.*

Floodlights

Two new general-purpose floodlights, Type L-82, rated at 300/500 watts and Type L-83 rated at 750/1000 watts designed for small area lighting, such as small sports areas, gas stations, parking lots, constructions, and platforms. A tightly sealed hinged door, which is locked by three clamping lugs, replaces the clamped ring on older types. Other features include an aluminum reflector designed for higher beam efficiency in accordance with NEMA standards and a locking handle on the elevation adjustment which eliminates the need for using wrenches. Both types can be provided with a portable base as well as the slip fitter and pipe clamp mountings.—*Lighting and Rectifier Divisions, General Electric Co., Schenectady 5, N. Y.*

Fractional-hp Motor

A new fractional-horsepower motor in ratings from ¼- to ¾-hp, 60-cycles, 1725- to 3450-rpm is now available for farm use. Two of the six new motors are of the split-phase type for driving grinders, fans and other equipment in which the starting load is normal. The remaining four are of the capacitor type for driving pumps, saws, elevators, etc., which constitute a high starting load.

All have dripproof end shields, sleeve bearings, and solid steel base with four bolt holes to facilitate mounting.—*Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

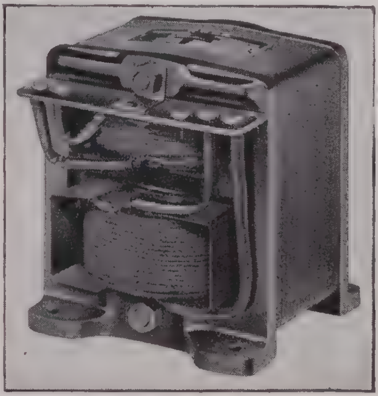
Temperature Controller

A new temperature controller uses a single electronic tube with an electrical resistance-type bulb for thermal pickup and is of the On-Off type. The use of the resistance bulb permits location of the sensing element at a point remote from the control panel and eliminates the necessity of thermal compensation. This device, which is nonindicating, can be used to control temperatures to close tolerances in solids, gases, or liquids. Units are available to cover the temperature range from −100 F to 1200 F and are adjustable within a range of several hundred degrees.—*Instrument Division, Thomas A. Edison, Inc., West Orange, N. J.*

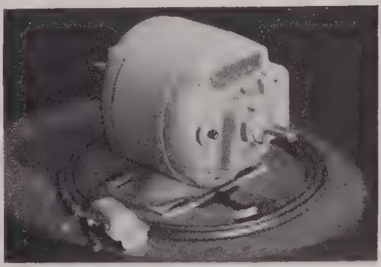
Transformer

The Type CVM-1 ballast transformer is a unit specifically designed to protect and stabilize the operation of the G-E Type UA-4 mercury vapor lamp, and it offers many advantages over ordinary high-reactance ballast transformers.

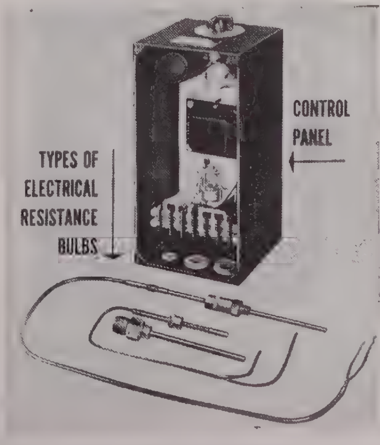
Operation of the lamp is completely stable and free from the effects of improper or widely varying line voltage. Lamp life is increased by preventing over-voltage operation, and lamp outages resulting from momentary voltage drops are eliminated. There can be no damage to the lamp from improper selection of primary taps, and constant spectral distribution of light output is maintained. The high input power factor permits operation of the lamp on 115-volt lighting circuits.—*Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.*



Transformer



Fractional-hp Motor



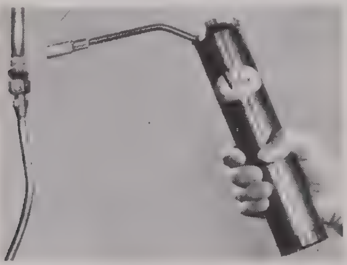
Temperature Controller

Variable Condenser

A new miniature variable condenser for applications where space is restricted and sturdiness is required. This condenser has a rated capacity of 9 to 585 $\mu\mu$f per section, with less than 0.002 dissipation factor at radio frequencies. The self-contained dial has micrometer action. The condenser can be temperature compensated, and it can be made up in many designs, ganged or single section.—*Engineering Research Associates, Inc., 1902 West Minnehaha Ave., St. Paul, Minn.*

Brazing Torch

The new Vulco heating and brazing torch, for use on hard or soft solders. This torch has no cumbersome hose, and starts immediately without preheating. The fuel supply, propane or butane, is carried in the 2¼-in. diam body. An average-size working flame will burn 10 to 12 hr continuously on one fuel filling. The calculated flame temperature is 3660 F. Including the capacity load of fuel, the weight of the torch is only 2 lb. —*Furlo Sales Co., 521 No. LaCienega Blvd., Los Angeles 36, Calif.*



Molecular Still

A new unit, Type CMS-5, for distilling fats, oils, and waxes by molecular distillation at the laboratory bench. A centrifugal evaporator employed by this still consists of a conical rotor 5 in. in diam, which is warmed by an embedded heater. The condenser is formed by a flattened surface of the bell-jar which encloses the complete unit. The bottom of the inverted jar contains the substance to be processed which is fed by a small circulatory pump onto the center of the rotor. Centrifugal force spreads it in a thin uniform layer across the surface of the rotor. The distillant is in contact with the heated evaporator for only 0.2 to 0.05 sec. Normal operating pressure of the still is 0.1 to 10 microns. Samples of two liters or less are handled most conveniently. A separate compartment collects the residue until a cycle is completed so that each fraction is a product of whole parent substance. —*Distillation Products, Inc., 755 Ridge Road, West Rochester 13, New York.*

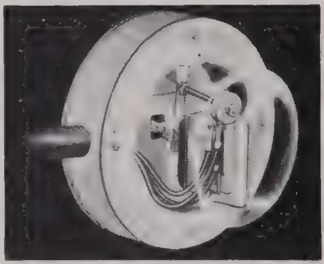
Television Generator

The new television generator, Model 610, is a single unit that replaces the ordinary television sweep generator used with marker generator, trap alignment generator, and crystal calibrator.

With the new television testing unit, an operator can visually align television receivers to any of the 13 present TV channels from 44 mc to 216 mc, visually align IF stages of a TV receiver including old and current bands, align all traps with a calibrated signal, modulated or unmodulated, and insert an accurate marker at any point along the IF response curve. Self-contained marker frequencies are directly calibrated on a large 9½-in. dial.—*Hickok Electrical Instrument Co., 10577 Dupont Ave., Cleveland 8, Ohio.*

Indicator Switch

A new Bin-Dicator, named the Bantam, designed for use on very small hoppers, spouts, chutes, conveyors, etc. This diaphragm-operated switch is in a sealed housing for mounting on the outside of bins, hoppers, etc., to signal changes in material levels. It will automatically start and stop filling and emptying equipment as the level of material reaches designated limits. These switches also are used to stop machinery when feed chutes or elevator boots become clogged with material.—*Bin-Dicator Co., Dept. J-908, 14615 E. Jefferson Ave., Detroit 15, Mich.*



V-belt

The new Royal Super Service V-belt is nylon-reinforced for increased strength and long life. The belt contains a series of nylon cords covered with a special synthetic-rubber compound capable of withstanding the deteriorating effects of heat and oil.

The belt is particularly suitable for power transmission on equipment subject to rough usage, such as grain-harvesting and processing combines, and railroads, mining, oil-well, and paper-processing machinery. In addition to having high tensile strength, it is flexible and sufficiently elastic to absorb shock.—*United States Rubber Co., Rockefeller Center, New York, N. Y.*

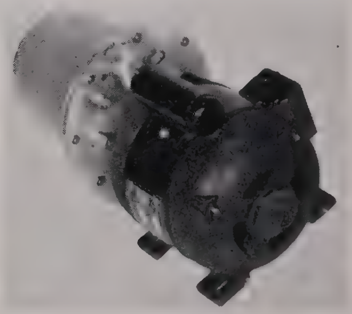
Rotary Switch

The Tesco rotary tap switch for use in circuits of exacting requirements. Each switch section with seven active positions and one OFF position is rated 50-amp continuous duty, with an overload capacity of 75 amp. As many as 12 switch sections in tandem can be operated in parallel to handle a maximum current of 600 amp. A current interrupter consisting of one or two micro-switches, rated 10 amp, and operated by the detent action, opens the source of power when the switch is rotated toward a new position, so that no arcing occurs at the switch contacts.—*Eastern Specialty Co., Philadelphia 40, Pa.*

Cutting Tool

A new triple-purpose hand tool known as the Shearite, for popular sizes of machine screws, also cuts and strips electrical wire Screws are cut off by this tool in any of the four sizes most used in electrical work. The screw to be cut is threaded into a tapped hole to desired length. Then the handles close and the end of the screw is sheared off clean, leaving screw free of burrs or damaged threads and ready for use without filing. An effective wire-stripper covering a wide range of wire sizes and a guillotine-type wire cutter add to the usefulness of the tool. It is made of high-strength alloy steel, hardened for long wear, and fitted with shock-proof plastic handles.—*Aircraft-Marine Products, Inc., Harrisburg, Pa.*

Midget Hydraulic Unit

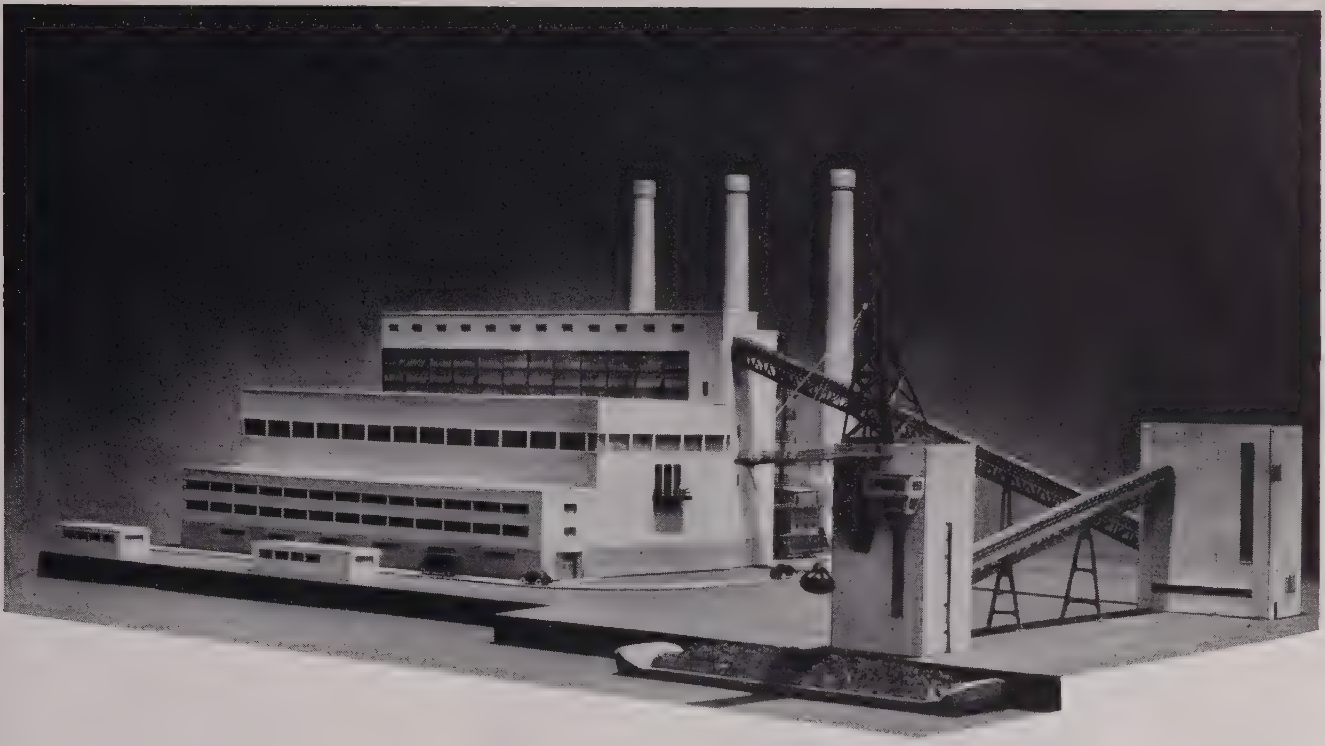


An addition to a line of 6-volt motor-driven hydraulic units makes units available for 110-, 220-, 440-volt, single- or polyphase power supply. The new unit is of a design which requires little or no installation cost and a minimum of floor space; or if preferred, the unit can be wall mounted The unit is available with pumps of various capacities and pressures, and includes a 5-pint-capacity reservoir and electric motor Most of these units can be supplied with a pressure relief valve and check valve mounted inside the tank or these valves can be mounted externally.—*John Dusenbery Co., 150 Pine St., Montclair, N. J.*

Resin Emulsions

Two new resin emulsions, designated R301-5 and R301-6, designed for the leather finishing industry contain a tough flexible resin which on evaporation yields a clear colorless film that is exceptionally low in water absorption. Film flexibility is obtained without the use of plasticizers; hence there is no tendency for the emulsion film to harden as a result of evaporation or migration of the plasticizer into the leather

(Continued on next left-hand page)



Steam will be hotter – at Sewaren

These three factors are the unwritten plus-values in every C-E contract –

Knowledge *– to solve today's, and tomorrow's steam generating problems.*

Experience *– to interpret, from a world-wide background in every important industry, the specific needs of each installation.*

Facilities *– to manufacture complete steam generating units for every requirement, from 30 boiler horse power up to the largest.*

In a power plant, steam temperature has a direct effect on economy and efficiency. Higher temperatures mean lower fuel cost and greater efficiency. But progress has trodden on the heels of the metallurgists and designers. Twenty years ago 750° F was a daring experiment. Today, with new alloys and improved designs, steam temperatures have passed the 1000° mark.

At Sewaren, New Jersey, the newest power station in the Public Service Electric & Gas Company system, steam will be generated . . . for the first time in power station practice . . . at 1050° F. The initial section of this station will house three huge C-E Steam Generating Units supplying steam at this temperature and at a pressure of 1500 pounds per square inch to three 100,000-kilowatt turbine generators.

The end, of course, is not in sight. Still higher steam temperatures will permit still greater economy and efficiency in power generation as soon as metallurgists can provide boiler and turbine designers with suitable materials. Combustion Engineering has played, and will continue to play, a leading part in this development. C-E was the first to design and build a boiler unit to operate at a steam temperature above 900° F. It is again first in the range above 1000° F.

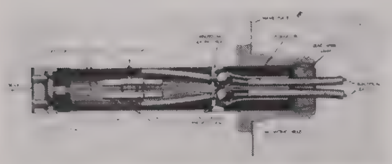
And the same engineering vision that has aided so materially in the development of high temperature units is reflected in C-E steam generating equipment for all industry, from units of 30 boiler horse power up to the largest yet built. B-116

COMBUSTION
ENGINEERING
200 MADISON AVENUE, NEW YORK 16, N. Y.

The R301-5 emulsion contains a soft, tacky resin possessing excellent pigment-binding properties. It is suitable for use as a clear sealer coat for leather splits or as a binder in pigmented covering coats.

The R301-6 emulsion contains a nontacky modification of the film-forming resin and is designed for use as a clear finish for fine side leathers where pigment binding is not of prime importance.—*General Electric Co., Chemical Department, Pittsfield, Mass.*

Fire Detector



Detect-A-Fire, a new fire-detecting device, combines high sensitivity, high-fidelity response to the temperature setting, and automatic repeatability, plus sturdiness and long life. Designed for application over a broad temperature range, the unit is suitable for both ordinary and explosion-proof applications. Because of a built-in anticipation effect, the unit operates at almost the precise calibrated temperature, regardless of rate of temperature rise. Its response is rapid because the temperature-sensitive element is the stainless steel casing. Expansion of the casing with temperature rise is transmitted to the inner strut assembly which magnifies the motion and operates the contacts. The strut construction is resistant to shock and vibration.—*Fenwal, Inc., Ashland, Mass.*

SMALL RUNS
on small parts
AT BIG SAVINGS

NEW METHOD CUTS TOOLING COSTS

Want to get precision parts in pilot lots without paying a fortune for tools? Or do you want just a few close tolerance stampings to prove your design before investing in permanent tools? The Short-Run Department of Instrument Specialties Co. is geared to handle just such headache jobs. And *fast*.

I-S methods eliminate costly tooling on shearing, bending, piercing. Precision is comparable to that obtained with permanent tooling. Delivery is quicker, cost far less. Parts can be produced in our Short Run Department in any quantity up to the point where permanent tooling becomes less expensive. Beryllium copper or any other heat treatable alloy lends itself to this new technique.

The I-S Short-Run Department is saving big money for some of America's best known concerns. An inquiry concerning your problem will get immediate attention.

INSTRUMENT SPECIALTIES CO., INC.
Bergen Blvd. Little Falls, N. J.

Welding Compound

A compound called Anti-Capillary for use with low-temperature welding rods confines the flow of molten alloys to the limited area upon which the weld is to be applied. This paste protects the parent metal from discoloration at welding temperatures and reduces the possibilities of distortion. The compound can be used with any form of heat, such as oxyacetylene gas torch, soldering torch, soldering iron, furnace, and high-frequency applications. The compound can be applied by painting, spraying, or with any type brush; and it can be removed by mechanical action, quenching, wire brushing, or sand blasting.—*Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y.*

Panel Instruments

A new line of 3½-in. panel instruments of internal-pivot design, Type DO-71, suitable for use in radio, power supplies, transmitters, amplifiers, and aircraft. The elimination of arc lines and distracting printing from the scale, and the use of a lance-type pointer and large clear numerals, assure accurate reading.

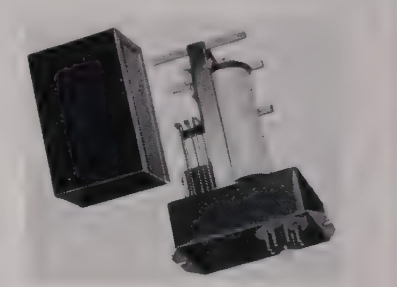
A high-strength alnico magnet provides high torque affording quick response and good damping so that the moving system follows changes in current or voltage rapidly and accurately. The high torque also allows the use of larger-radius pivots, resulting in increased resistance to shock and vibration. There is a large clearance in the air gap between the pole faces and core which minimizes the possibility of the stickiness that normally results from collection of dirt and foreign particles in the air gap under adverse conditions.—*Meter and Instrument Divisions, General Electric Co., West Lynn, Mass.*

Metal Cleaners

Two new metal cleaners, effective individually or in combination, for cleaning a wide variety of metals and alloys. Cleaner No. 21 is a dry granular alkaline detergent for spray-cleaning in metal-washing machines. The build-up of lime scale or other deposits on pipe lines, pumps, heating coils, nozzles, and tanks as a result of water hardness is a problem effectively solved by use of this cleaner. In addition, it has proved effective when used in combination with the new Emulsion cleaner, for immersion cleaning in dip tanks and for heavy-duty spray cleaning. The latter is a white, creamy emulsion of an organic solvent in a relatively small amount of water. It readily disperses when added to the cleaning bath. This mixture or combination of the two cleaners provides the advantages of an alkaline cleaner with those of an organic solvent.—*Calgon, Inc., Pittsburgh, Pa.*

Enclosed Relay

A dust-tight plug-in relay base and cover for use in plant locations where dust conditions may affect operation of unprotected relays. The assembly consists of an a-c or d-c relay mounted on a dust-tight base, with the terminals brought through a closely fitted Neoprene gasket. The steel cover, firmly secured to the base by a thumb nut, can be readily removed for inspection of the relay. Either a standard radio-type plug or a 15-point plug of different design complete the installation.—*C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Ill.*



Conduit Fish Tape

New Jiffy No-Kink fish tape for aluminum and steel conduit. A new principle applied to fish tape design enables this product to easily be pushed or pulled around four bends in aluminum or six bends in steel conduit. This rust-proof aircraft-control-type cable tape is galvanealed-spring protected to prevent kinking. It will not gouge and stick in aluminum thin wall, and it pulls over box edges and conduit ends without curling.—*Clyde W. Lint Co., 1142 W. Washington Blvd., Chicago 7, Ill.*

Loom Motor

A new totally enclosed Tri-Clad loom motor specially designed to meet the particular requirements of loom operation. Although covering the entire range of 2 hp, 1800 rpm, and smaller, all ratings are built in a single frame diameter with but two axial lengths. This permits changing horsepower or speed ratings on a particular loom to suit mill requirements with minimum loom modification. All ratings are available for foot mounting or for three-arm suspension.

In addition to the advantage of a single frame diameter, the new motor includes more conveniently located oil fittings and a new design wool-packed steel-backed bronze sleeve bearing. An oil-resistant multiconductor jacketed cable is furnished to withstand the heavy vibration met in loom applications.—*Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

TRADE LITERATURE

Fabricator—Versatility of this sheet metal fabricator with Hyda-New-Matic drive is apparent from the descriptive information disclosing that it punches, notches, nibbles, bends, blanks, and forms. These various operations together with the accessories needed to perform them, are numerously and clearly illustrated. Equipment and specifications are listed. Twelve pages. Catalog 10-A.—*Wales-Strippit Corp., North Tonawanda, N. Y.*

High-vacuum Indicator—Operation, construction, design and specifications of an absolute pressure indicator is presented in this pamphlet. Both the 2¾-in. and 6-in. dials are illustrated, and several new ranges are listed. Four pages. Technical Publication 16A.—*Wallace & Tierman Products, Inc., 1 Main St., Belleville 9, New Jersey.*

Laminated Plastics—Presented in this folder are the general properties and uses of National vulcanized fibre, Phenolite laminated plastic, and Peerless insulation. Grade specifications for each are given. Four pages.—*Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 7, Ill.*

Ni-Hard Castings—A concise well-organized Buyers' Guide presenting the facilities, specialties, and locations of authorized producers of Ni-Hard which are alphabetized under an alphabetical arrangement of states. This booklet is accompanied by an abrasion-problem questionnaire enabling those interested to submit information and receive recommendations for a suitable material. Eight pages. 1948 Edition, first revision.—*International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.*

Pulley Puller—A portable hydraulic puller for removing objects from shafts is the subject of this descriptive circular. Illustrations and a table of capacities supplement the text. Four pages.—*Industrial Engineering Equipment Co., 122 E. Fourth St., Davenport, Iowa.*

Silicones—An indexed, illustrated, and well-arranged bulletin attractively presenting the story of silicone products which are classified as resins, oils, greases, water repellents, and rubber. The characteristics of these products are described, together with their varied industrial uses. Several charts and tables contain useful data. Thirty pages. Bulletin No. CDR-57.—*General Electric Co., Chemical Dept., Pittsfield, Mass.*

Soldering—This pocket-sized leaflet explains the construction and advantages of Tri-Core solder wire for radio and electrical work and also dripproof acid-filled solder for use on metals other than aluminum and magnesium. Included in the mailing piece are brief explanations of other related products: anodes; extruded shapes; solders; preforms; fluxes; and lead and tin specialties. Six pages. Entitled "Speed Soldering."—*Alpha Metals, Inc., 363 Hudson Ave., Brooklyn, N. Y.*

Voltage Drop—A neatly indexed looseleaf booklet titled "Estimating Voltage Drops Caused by Starting A-c Motors" contains detailed technical information and engineering application data concerning the many factors needed for estimating the voltage during disturbances caused by starting three-phase induction and synchronous motors. The descriptive material is aided by installation pictures, curves, and circuit diagrams. Twenty-six pages. GET-1445A.—*General Electric Co., Apparatus Dept., Schenectady 5, N. Y.*

FOR HIGH-SPEED, SENSITIVE RECORDINGS

Photoelectric Recorder..

WAS SELECTED BY MINNESOTA MINING & MANUFACTURING CO.

The Minnesota Mining and Manufacturing Company is using a General Electric Photoelectric Recorder in preliminary studies of new machine designs. Here, it is being used for recording oil pressure in evaluating the application of an automatic, variable-speed, hydraulic drive to process equipment. As a result of this study, several changes were made on the oil drive which enhanced its performance and life expectancy in the particular application.

G-E High-speed Photoelectric Recorder

The Minnesota Mining and Manufacturing Co., is just one of the many users who have found the G-E Photoelectric Recorder useful in solving their problems. It is also used for thermocouple response tests, resistance thermometry, and general physiological research. In fact, its extreme sensitivity and high-speed response make it ideally suited to many other applications embracing the entire field of measurements. It can RECORD ANYTHING THAT CAN BE MEASURED by an indicating instrument.

A wide range of sensitivities (which go as low as 1.0 microamperes for full-scale deflection) and response speeds (as high as $\frac{1}{4}$ second) are available in the photoelectric recorder. Basic elements are interchangeable so that one instrument can cover a number of ranges. It is also available as a potentiometer recorder. Write for Bulletin GEA-2394, or contact your nearest G-E Sales Office and let us help you with your application problems. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

602-124

For best commutation, brush holders must be set at the right neutral position, especially when units have been rewound. In generators, this point is ahead of the no-load position, in motors it is behind. The exact neutral position is determined by one of four accepted methods, any of which Speer's engineering department is prepared to apply to your problems. It is also vitally important that the right brushes be selected.

The Speer Carbon Company, makers of top-quality carbon brushes for over 50 years, is prepared to survey your operation. Our engineers will recommend brushes for best all-around performance. Call the Speer man and profit from his experience and knowledge.

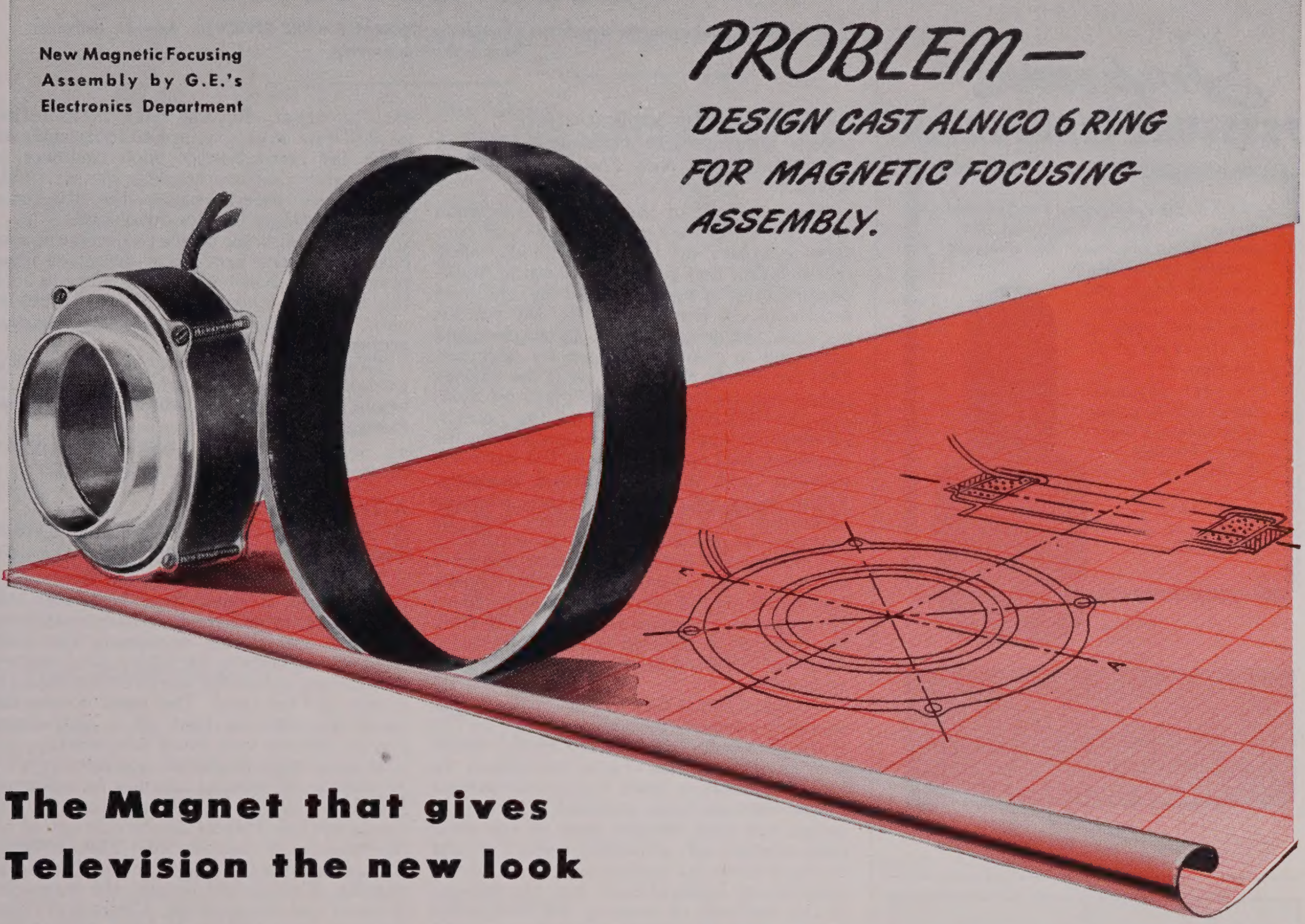
Speer
CARBON COMPANY
ST. MARYS, PENNA.

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

CHICAGO · CLEVELAND · DETROIT · MILWAUKEE · NEW YORK · PITTSBURGH

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS

New Magnetic Focusing
Assembly by G.E.'s
Electronics Department

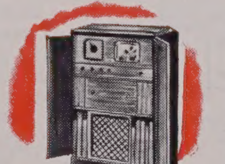

PROBLEM—
DESIGN CAST ALNICO 6 RING FOR MAGNETIC FOCUSING ASSEMBLY.

The Magnet that gives Television the new look

Now it's permanent magnets for better television reception. The permanent magnet shown above keeps electrons on the beam . . . eliminates blurring of the television picture. Once the set has been focused further adjustments are unnecessary. And, the use of a G-E permanent magnet results in greater efficiency since no heat is generated by the Cast Alnico ring magnet.

An outstanding feature of this ring magnet is the very thin wall section developed by G-E process engineers. Heretofore this was possible only with sintered magnets. Better permanent magnets as well as new applications are constantly being developed by G-E engineers.

Perhaps you can improve the efficiency of your product with G-E permanent magnets. General Electric will be glad to work with you to improve your product. Greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. All are produced under rigid quality control methods. This assures you of receiving magnets of the highest uniform quality for your application.



Clear, sharp television reception with the new G-E Magnetic Focusing Assembly.

The magnetic field set up by the assembly focuses the electron beam on the television screen. The combined effect of the G-E Cast Alnico 6 permanent magnet and a small coil produces this magnetic field axial with the tube neck. The ring magnet supplies the bulk of the magnetic flux while the coil acts as a vernier adjustment. The punched pole pieces collect the magnetic flux and direct it into a uniform radial pattern.

Outstanding advantages of this new assembly are increased efficiency and compactness. Defocusing due to line voltage fluctuation and warm-up drift is eliminated.

METALLURGY DIVISION
CHEMICAL DEPARTMENT, SECTION CR 8
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

Please send me:

☐ Bulletin CDM-1, "G-E Permanent Magnets."

Name...Title....................
Company..
Products Mfrd..
Address...
City...State......................

PERMANENT MAGNETS

GENERAL ELECTRIC

CD48-V8

Improved
PRESSURE TRANSDUCER

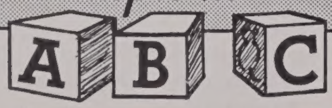
The improved type 4512 Giannini Pressure Transducer is smaller and lighter than standard instruments. This instrument combines smaller size with high outputs and accurate readings. Even at low pressures, it retains all of its accuracy.

This absolute, differential, or gauge-type Pressure Transducer is available in ranges up to 40 psi. The new type 4512 is available for immediate delivery.

Write for engineering details.

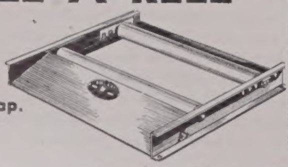
GM Giannini & CO INC
REACTION POWER PLANTS • AUTOMATIC FLIGHT EQUIPMENT
285 WEST COLORADO STREET • PASADENA 1, CALIFORNIA

Simple as



Handle heavy reels easily and safely; remove wire or cable from top or bottom, front or back of reel with

ROLL-A-REEL



Style A:
2,000 lbs. cap.
37.50

Style B:
4,000 lbs. cap.
75.00

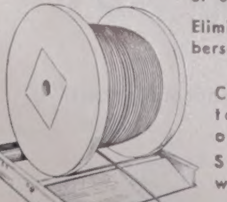
F.O.B. Cincinnati

Low slanted front and positive front lock insure quick loading or unloading.

Eliminate jacks, cumbersome handling.

Carried easily to reels, job or storage.

Sold through wholesalers only.



WRITE TODAY FOR DETAILS

ROLL-A-REEL
327 WEST FOURTH STREET
CINCINNATI 2 OHIO

BOOK REVIEWS

(Available books may be purchased through the GENERAL ELECTRIC REVIEW for domestic delivery; none sent on approval.)

Aluminum and Its Applications

Hiram Brown and Associates—Pitman Publishing Corp., New York. 1948. 352 pp. $5.75.

The first half of the book is concerned with the technology of aluminum and contains chapters on testing methods, alloy classification and properties, casting methods, methods of working, finishing, and heat treatment. In the second half, the various applications are profusely illustrated and described in chapters written by engineers who are closely associated with the various industries. Included are chapters on aviation, aircraft engines, castings for aircraft, automotive applications, railroads, marine exposure, and applications in the electrical industry and in the chemical industry. While some of these chapters mention aluminum in a general manner, with no reference to particular alloy, the section on the automotive industry not only describes the now limited applications but suggests specific alloys and products for replacement of copper and ferrous alloys in parts from the radiator to the fuel tank. Many useful data are collected in the twenty pages of appendices.

In regard to the first half of the book, it is probably adequate for a rudimentary survey of the aluminum industry for the lay reader if a few inaccuracies can be overlooked. In some instances, a good balance of subject matter has not been attained. The author points out that 89 per cent of the total consumption of aluminum was in the wrought form (as further suggested by the chapters on applications); yet descriptions of ten methods of working are compacted into a 17-page chapter, whereas casting methods consume a 21-page chapter. Likewise, a short paragraph is used to describe each of two new Al-Zn-Ag wrought alloys, while five pages are devoted to a casting alloy of this type. Nevertheless, frequent recourse to publications of the metal producers, combined with the chapters on modern applications, serve to make this a compact volume on aluminum and its alloys.

A. H. Geisler

Methods of Algebraic Geometry, Vol. I

W. V. D. Hodge and D. Pedoe—Cambridge, at The University Press, 1947; New York, The Macmillan Co., 1948. 448 pp. $6.50.

This volume is the first of a projected two-volume study of the foundations and methods of algebraic geometry.

The work is directed toward the mathematician and the mathematical physicist. As an item in the library of an engineer, its use would be principally that of an exercise in mathematical logic.

It was the desire of the authors to present all possible aspects of the subject in a book of reasonable size. For this reason, only the more general methods of attack are presented, and specific examples are rarely introduced. Such applications are promised as a part of the second volume, as yet unpublished.

The subject matter of the volume is divided into two "books"; the first book being concerned with algebraic theorems and relationships, and the second book with the theorems of projective space.

The first book is initially devoted to the algebraic properties of sets of elements when the rules of addition, subtraction, multiplication, division, and the solution of algebraic equations are suitably defined. With the restriction of such elements to linear algebraic expressions, vectors, matrices, and determinants, the algebraic relationships are further developed.

The second book treats projective spaces based upon the previously discussed algebraic sets. Such spaces are defined from both the algebraic and the synthetic points of view, and their geometric and algebraic properties are investigated.

This volume displays the typical fine workmanship of the Cambridge Press and would be a worthwhile addition to a mathematical library.

Jackson E. Fowler

A Textbook of Heat

G. R. Noakes—The Macmillan Co., New York. 1947. 469 pp. $3.00.

"A Textbook of Heat" is an elementary presentation of basic heat laws and test techniques, intended for British sixth-form students specializing in science. The sixth form corresponds to our high-school seniors, who do not ordinarily use so comprehensive a text at that level. The book covers the usual material on heat of a high-school physics course, very much amplified.

It apparently is offered concurrently with a course in differential calculus, for although the first chapter, on temperature, is not mathematical, thereafter the concept of infinitesimals is introduced. The subjects covered include the measurement of heat, expansion of solids and liquids, the expansion of gases and the gas laws, vapors and vapor pressure, heat and work, heat engines, the second law of thermodynamics, liquefaction of gas and production and measurement of low temperatures, transference of heat, and heat phenomena in the atmosphere.

Each chapter is followed by questions taken from entrance examinations of the British universities. Some of the questions are difficult, as for example this one taken from the Cambridge examinations: Explain in general terms the kinetic theory of liquids and gases, and apply it to explain the phenomena of evaporation, boiling, saturated and unsaturated vapors, and the pressure of gases.

This would be a useful text for first-year college students in the fields of physics and chemistry, and chemical and mechanical engineering.

Florence F. Buckland

Eleven- and Fifteen-place Tables of Bessel Functions of the First Kind, to all Significant Orders

Enzo Cambi—Dover Publications, Inc., New York. 1948. 160 pp. $3.95.

This book contains tables of Bessel functions $J_n(x)$ for values of x ranging from 0 to 10.5 at intervals 0.01 for all significant integers n, and additional fifteen-place tables for x ranging from 0 to 0.5 at intervals to 0.011. Also included are graphs of the upper limits of error, a description of several "checks," and Taylor expansions for J_n near integer values with twelve-place accuracy for the coefficients.

These tables should prove useful in any calculations involving Bessel functions to a high order of accuracy.

H. Poritsky

LIBRARY NOTES

ON ARTICLES IN OTHER TECHNICAL JOURNALS

ARC WELDING

Welding the Giants

L. J. McDonough—*Weld. Engr.*, Apr. 1948; v. 33, pp. 51-53

Here are presented the facts which prove that production costs of heavy machinery have been greatly reduced through the use of arc welding.

ATOMIC POWER

Industrial Application of Nuclear Energy

Lyle B. Borst—*Mech. Engng.*, Apr. 1948; v. 70, pp. 295-297

What Happened in Atomic Energy in '47?

Elec. Wld., Apr. 10, 1948; v. 129, pp. 97-104

Electrical World's second report on the nontechnical aspects of the atomic energy program.

AUTOMOBILES

Buick's Dynaflow Drive Built to Aircraft Tolerances

Charles H. Wick—*Mach.*, Apr., 1948; v. 54, pp. 135-142

Combines a fluid coupling with a hydraulic torque converter.

AVIATION—TRAFFIC CONTROL

They Call It "Tricon"

Aero Digest, Apr. 1948; v. 56, pp. 42-45, 98-100, 102

The "Triple Coincidence" electronic method of air navigation, foreshadowing our official skyway traffic system.

COMPRESSORS, GAS

High-speed Flow Through Cambered Rotating Grids

Frank L. Wattendorf—*Jour. Aero. Sci.*, Apr. 1948; v. 15, pp. 243-247

The theory of gas flow as it occurs in axial compressors used as components of gas-turbine propulsion systems.

ELECTRIC CABLES, COAXIAL

Heating of Radio-frequency Cables

W. W. Macalpine—*Elec. Commun.*, Mar. 1948; v. 25, pp. 84-99

A mathematical and physical analysis of the heating of solid-dielectric coaxial cable is given, including a practical application.

ELECTRIC DISTRIBUTION

Secondary Network Operation—A Symposium

Elec. Lt. & Pr., Apr. 1948; v. 26, pp. 68-80

Three articles, by different authors, covering operating experiences as they influence design, outage experiences, and re-energizing low-voltage a-c networks.

ELECTRIC HEATING

Control of Automatic Resistance Heating Machine

M. B. Ladd—*Elec. Mfg.*, Apr. 1948; v. 41, pp. 118-121

Uniform heating of forging blanks by low-voltage, high-amperage current is closely controlled by phototubes which actuate relays, and through them solenoid valves, hydraulic clamping contacts, and heat-transformer input switches.

FREQUENCY CHANGERS

Thyratron Frequency Changers

O. E. Bowlus and P. T. Nims—*Electronics*, Mar. 1948; v. 21, pp. 126-130

Designed to permit parallel operation of three-phase aircraft alternators driven at unequal and varying speeds, the converter and control circuits described here produce three-phase power having constant frequency and regulated voltage.

GAS TURBINES

Production of Manufactured Gas Using Gas-turbine Cycles

Frank J. Jenny—*Chem. Engng.*, Apr. 1948; v. 55, pp. 108-111

The possibility of utilizing gas-turbine cycles wherein power in excess of process requirements can be made available. Continuous gas-manufacturing processes using gas turbines are outlined.

Problems of Gas-turbine-propeller Combinations

Frank W. Davis—*Aero. Engng. Rev.*, Apr. 1948; v. 7, pp. 30-36

An account of experiments with the TG-100 gas-turbine propulsion system in the XP-81 Vultee plane.

GRINDING AND POLISHING

Optical Grinding—The Latest Development in Toolmaking

Charles H. Wick—*Mach.*, Apr. 1948; v. 54, pp. 154-160

Extremely accurate profile shapes on parts such as form tools, lamination dies, and templates are being ground quickly and economically by means of optical grinding machines.

HEAT PUMP

Research Aspects of the Heat Pump

E. N. Kemler and N. Kulik—*Heat Piping & Air Cond.*, Apr. 1948; v. 20, pp. 107-112

A comprehensive tabulation of the various items to be considered in preparing a program of research on the heat pump is included.

HEAT TRANSFER

Heat Losses From Tanks, Vats, and Kettles

Samuel J. Friedman—*Heat & Vent.*, Apr. 1948; v. 45, pp. 93-108

Includes graphs and tabulated data for use in calculations.

INTERLOCK DEVICES

Interlocks

R. B. Immel—*Mach. Design*, Apr. 1948; v. 20, pp. 131-148

Basic and typical control circuits involving both electrical and mechanical interlocks are tabulated, with description of a variety of methods and devices for protecting machines against faulty operation.

LUBRICATION AND LUBRICANTS

Oil Flows and Running Temperatures of Lightly Loaded Journal Bearings

John Boyd and B. P. Robertson—*Lubrication Engng.*, Apr. 1948; v. 4, pp. 58-62

The theory of pressure-lubrication of high-speed bearings. Test results are also included.

MEASURING INSTRUMENTS

X-ray Goniometer for the Study of Preferred Orientation in Polycrystalline Aggregates

W. A. Wooster—*Jour. Sci. Instr.*, Apr. 1948; v. 25, pp. 129-134

For the purpose of studying the preferred orientation of crystals in metal sheets or other polycrystalline aggregates.

Basic Design and Field Performance of the Control and Measurement Instrumentation of an Alkylation Unit

Harry F. Moore and George W. Gross—*Instruments*, Apr. 1948; v. 21, pp. 368-374

Equipment for control and measurement in a petroleum refinery.

METALS

Manufacture and Application of Composite Plates

O. R. Carpenter—*Weld. Jour.*, Apr. 1948; v. 27, pp. 279-287

Describes the resistance-seam-welding method of producing stainless-steel-clad plate, the apparatus needed, together with physical and metallurgical properties.

Gases in Cast Metals

Michael B. Bever—*Iron Age*, Apr. 22, 1948; v. 161, pp. 90-94

Reviews the theory of gas-metal interaction and behavior from the standpoints of unsoundness in castings, sources of gases in standard casting operations, solubility of the common simple and compound gases in various metals and alloys, and the factors governing this solubility.

PLASTICS—RAW MATERIALS

Ready-to-Cast Compound

John Delmonte—*Modern Plastics*, Apr. 1948; v. 25, pp. 98-101

Supplementing cast plastics in certain applications, this new composition may also be used in dies for embossing acrylic and copper. The properties of Calcerite are described.

POWER COSTS

Economies in Design, Construction, and Operation Control Rising Costs of Hydro Power

M. G. Salzman—*Civil Engng.*, Apr. 1948; v. 18, pp. 23-27

POWER TRANSMISSION

How to Classify Power Transmission Requirements

Edwin Laird Cady—*Mill & Factory*, Apr. 1948; v. 42, pp. 110-113

A 38-point check list of factors which could be considered for any power-transmission sequence and for the various sequence members.

REFRIGERATING ENGINEERING

Condensation of Refrigerant Vapors—Apparatus and Film Coefficients for Freon-12

R. E. White—*Refrig. Engng.*, Apr. 1948; v. 55, pp. 375-379

Describes an apparatus for the direct determination of condensing-vapor heat-transfer film coefficients in which precision measuring methods are employed.

STEAM TURBINES

Regenerative Reheating Possibilities in Steam Turbines

W. E. Caldwell—*Power Gen.*, Apr. 1948; v. 52, pp. 56-57, 110, 112

How reheating of steam in the later stages of a steam turbine with bleed steam in hollow blades can reduce losses caused by moisture.

STREET LIGHTING

Outdoor Street Lighting Laboratory an Effective Promotional Tool

Jim Goggin—*Elec. Lt. & Pr.*, Apr. 1948; v. 26, pp. 96-98, 100

Two intersecting streets—one arterial and the other residential—are the site for this full-scale laboratory, dedicated to selling city officials on higher-quality rather than low-cost street lighting.

THERMODYNAMICS

Thermodynamic Properties of Hydrogen Sulfide

James R. West—*Chem. Engng. Prog.*, Apr. 1948; v. 44, pp. 287-292

Strings ARE FOR PUPPETS

Some words have a way of belonging together. Pull them apart and their meaning falls apart.

For example — Free Enterprise. Banish "free", and "enterprise" too vanishes. Not only in import, but in fact.

Let's delve a little further into this matter of words. "Enterprise," says the dictionary, is "boldness, energy and invention in practical affairs."

Kill off free enterprise, and what happens? Instead of boldness, you have timidity. For energy, you get inertia. Instead of invention, there is indifference. Not a decent swap in the lot — from the American point of view. Deprived of free enterprise, we become puppets — our every movement dependent on "strings attached."

Yet there are those who protest free enterprise as something sinister.

Look closely — for the knot of a string on their waggling fingers.

Sherron Electronics
W2XDK

SHERRON ELECTRONICS CO.

DIVISION OF SHERRON METALLIC CORPORATION

1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK

MANUFACTURERS OF ELECTRONIC DEVICES AND SHEET METAL FABRICATION